The FOUNDRY

Volume 47. No. 8
Whole No. 324

Published
Semimonthly

CLEVELAND, OHIO, JUNE 1, 1919

Where Power Transmission Machinery is Made

Description of a New Western Foundry Specially Designed for the Production of Pulleys, Clutches, Gears, and Other Specialties

PEACE has its victories no less renowned than those of war. For the past few years with war talk on every side, with everybody interested in munitions, tractors, clothes, food and ships it was only natural that little was heard of the work going on behind the scenes. For every victorious general there were thousands of men engaged not only in fighting, but in making munitions and equipment, in observation and transportation, in growing crops and running ships; and to make their work possible, quantities of machinery were needed.

Away back, not at the actual beginning of the chain of operations for that would take us back to the ore pile and the blast furnace, but near the beginning, were the plants devoted to the manufacture of power-transmission machinery. The product of these plants went into every gun shop and shell factory as well as into every shipyard and ordnance repair station at the front. In short the efforts of the builders of power-transmission equipment, including pulleys, gears, clutches, countershafts, etc., formed an important link in that great chain of war effort which pulled the kaiser off his pedestal. But unlike much war equipment, this apparatus is equally necessary and useful in times of peace—it has a permanent value.

An examination of the foundry practice of manufacturers of power-transmission machinery, therefore, presents features worthy of study during the present transition from war to peace. One of the most interesting plants in this field is that operated by the W. A. Jones Co., Chicago. This concern furnished a large amount of power-transmission equipment to munition plants, shipyards, etc., during the war. Now it is turning its attention to peacetime activities.

The general arrangement of the W.

FIG. 1—GENERAL VIEW OF FOUNDRY DESIGNED FOR TURNING OUT POWER TRANSMISSION MACHINERY

FIG. 2—THE BARROW LOADS OF COKE AND IRON ARE WEIGHED BEFORE GOING IN THE ELEVATOR—NOTE THE LOAD, 1000 POUNDS

A. Jones Co. plant is shown in Fig. 8. The various departments are so located that the work may be routed conveniently from the pattern shop, through the foundry and cleaning room into the machine shop and finally out through the shipping room.

The foundry, cleaning room, machine shop and shipping room are all connected and under one roof. The cleaning room occupies part of a 2-story building. One-half of the upper story is devoted to the general offices and the other half to wash stands, shower baths and lockers for the employes' clothing, separate installations being provided for the machine shop and foundry. The pattern shop is in a 2-story building, 92 x 76 feet. The lower floor is used for the pattern storage. The upper floor is equipped with all the necessary woodworking tools for making and repairing patterns. The boiler room and power plant is also housed in a separate building which is situated in the space between the lower end of the foundry and the machine shop.

The foundry itself, as shown in Fig. 8, is 220 feet in length and 130 feet in width. The building is of standard brick and steel construction with a monitor roof carrying floor-operated hinged sash. The shop is divided by the columns supporting the monitor into three bays; one, in the center, is 50 feet, and two, on the sides, are each 40 feet in width. The center bay is served by a 10-ton crane and the side bay next to the machine shop by a 5-ton crane. The cupola is located near one end of one of the side bays, with the core room alongside. The foundry has a floor space of 28,600 square feet.

The pig iron and coke are unloaded in the yard, as shown in Fig. 8, but sand, clay, facing, corebinder, etc., are brought into the plant on the track shown at *A* and unloaded into suitable bins situated alongside the foundry building. All this material is thus readily available to the coremakers and molders.

Core Oven Arrangement

The core ovens are fired from the inner end thus giving the coremaker a chance to watch his fire without having to walk back around the outside. The location of the ovens is also worthy of comment. They are situated under part of the cupola charging floor thus utilizing a large amount of space which under ordinary circumstances is either wasted or piled up with rubbish. Between the roof of the ovens and the mezzanine floor is 2 feet of dead space. On the mezzanine floor are the motor and fan for the cupola. This arrangement does away with long lengths of piping and is one of the factors that make for greater efficiency.

Fig. 2 shows the scale over which all the coke and iron passes on its way to the cupola. The coke is wheeled in ordinary barrows which hold about 200 pounds each, but the pig iron is loaded on special trucks having two wheels nearly under the center. This arrangement enables one man to wheel 1000 pounds on each trip. The charging floor, as may be seen from Fig. 3, is extensive and roomy. This is owing to the fact that when the foundry was built provision was made for two cupolas side by side. One has been found quite ample to supply all the iron required so far. In the meantime the extra space is utilized to hold a reserve stock of coke, something which is appreciated when the weather is unfavorable. This arrangement also insures having a supply of dry coke with which to start the fire each day.

The furnace is lined to 60 inches and melts the daily cast of 20 tons in less than an hour and a half. The bed charge consists of 2400 pounds of coke. The regular charges are 700 pounds each. A custom prevalent in several shops of making the first iron charge heavier than the succeeding ones is followed. The first charge is 6000 pounds and those following are 4000 pounds each. No attempt is made to find the lowest point at which iron will melt. The nature of the work calls for clean hot iron and

FIG. 3—PUTTING IN THE COKE BED. TO OBVIATE A SECOND HANDLING THE COKE FORMING THE BED IS DUMPED IN DIRECT FROM THE BARROWS

no scrimping of coke is permitted to interfere with obtaining the kind of iron necessary. The mixture varies from time to time depending on the quality of the coke and pig iron and sometimes on the nature of the work. An average charge would be 2550 pounds of hard pig, 600 pounds of soft pig and 850 pounds of return scrap. The analysis of this iron will run about 2.00 to 2.25 per cent silicon, 0.04 to 0.10 per cent sulphur, 0.60 to 0.70 per cent phosphorus and 0.50 to 0.70 per cent manganese.

The molten iron is carried to the different parts of the shop in buggy ladles which run on a narrow-gage track. There are turntables in the track at each corner of the main bay. By this arrangement it is a relatively simple matter to deliver iron to any part of the foundry. The molders take their iron from the buggy ladles in shanks and hand ladles. The molds in the main bay are poured with the crane.

FIG. 5—LOOKING IN FROM THE SHIPPING END OF THE MACHINE SHOP

FIG. 4—A SPECIAL SKYLIGHT FURNISHES AMPLE LIGHT TO THE BENCH MOLDERS

Fig. 1 shows a general view of the main bay of the foundry. The lighting and ventilating arrangements are unusually good. As previously explained this bay is 220 feet in length by 50 feet in width and is spanned by a Whiting 10-ton electric crane.

The method of molding large pulleys, or those having special features, is illustrated in the foreground of Fig. 1. An iron ring pattern of the proper diameter is bedded in level in the floor, and centered by a spindle. A complete stock of ring patterns of various sizes is kept on hand. The sand is rammed on the inside of the the required face of the pulley. It ring to a certain height depending on is then struck off with an arm attached to the spindle. The arms and hub, which are made in cores are next set in place, and the sand rammed as high as necessary. It is finally struck off, slicked and the spindle removed. A suitable cheek is next rammed on the outside, struck off to the same height as the inside and the parting slicked. The pattern is then drawn, the cheek lifted off, the inside finished and blacked and the cheek replaced. The rim and hub are covered with cake cores which are suitably weighted. When the runner is made up the casting is poured. The molders pour and shake out their own work and dig out the center cores. Fig. 4 shows the benches at one end of the bay in which also are located the core ovens and the cupola.

Located on the opposite side of the shop are the molding machines on which the smaller sized pulleys are

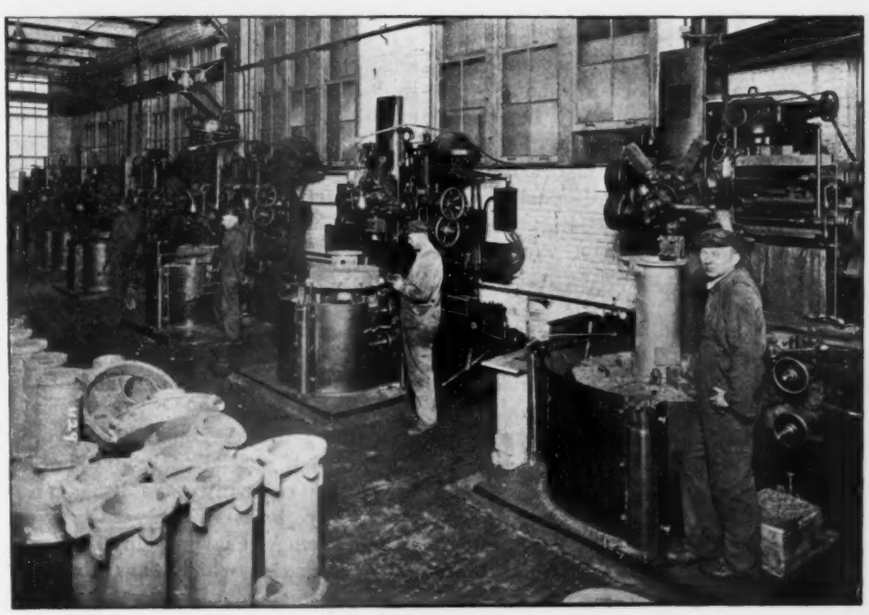


FIG. 6—ONE END OF MACHINE SHOP SHOWING A BATTERY OF BORING MILLS

made. These machines were all built by the W. A. Jones Co. Each one consists of a round plate mounted on a suitable stand with a hand lever to operate the pattern and a rack to adjust the pattern to any height. When the mold is rammed the pattern is pulled down through an opening in the plate and the flask is lifted off. The pattern is then returned to its place and another flask put on. The sketch, Fig. 7, shows a sectional view of the construction and operation of this machine. The forked lever *A* embraces the lower end of the pattern and is secured by two bolts, one on each side. These bolts are firmly attached to the pattern but slide in the slots in the lever marked *B*. The double end of the fork is attached to two lugs cast integrally with the stand while the other end projects through an opening on the opposite side and serves for a handle to manipulate the pattern. By inserting a pin in any of the holes in the rack *C* the pattern can be adjusted to any height. The top of the machine is open and therefore by the use of different filling-in rings a variety of diameters can be made on each machine.

The flasks are filled with sand and rammed by hand, but the fact that each half of the mold is rammed independently of the other on an iron plate and against the same center lines guarantees a true joint and a perfect line up on the face. As a result chipping is reduced to a minimum.

All gear wheels made by this company having the same pitch are made the same width on the face irrespective of their diameter. Thus no matter what combination of gears is called for in any installation, all those of the same pitch will occupy the same lateral space. No special equipment is used for molding them. Some are molded in the floor but most of them are rolled-over and made in ordinary flasks.

The cleaning room is equipped with tumbling barrels and with wheels for grinding the small castings. The large castings are all cleaned and chipped by hand. The machine shop, a general view of which is shown in Fig. 5, is particularly well equipped to handle the class of work in which this company specializes. There are a large number of turret lathes, boring mills, planers, gear hobbing machines, and machines for cutting keyways. A battery of seven Bullard boring mills is shown in Fig. 6. The spur gears are all cut on hobbing machines and the bevel gears on planers. An effort is made to observe extreme accuracy in gear cutting. On leaving the machine shop each pulley is mounted on a pair of horses and tested for balance. When the necessary adjustments have been made it is taken to the shipping room and is either shipped immediately or stacked with a number of its fellows until the remainder of the order is made up.

Contrary to the custom of most shops which specialize in one line of work, this company pays its men on an hourly basis. The officers are rather firm believers in the old foundry maxim which says that one good casting a day is worth two bad ones. An idea of their labor policy may be gained from the fact that most of their employes have been with them for many years. The foreman molder and foreman patternmaker, for instance, have been with the W. A. Jones Co. for over 25 years each.

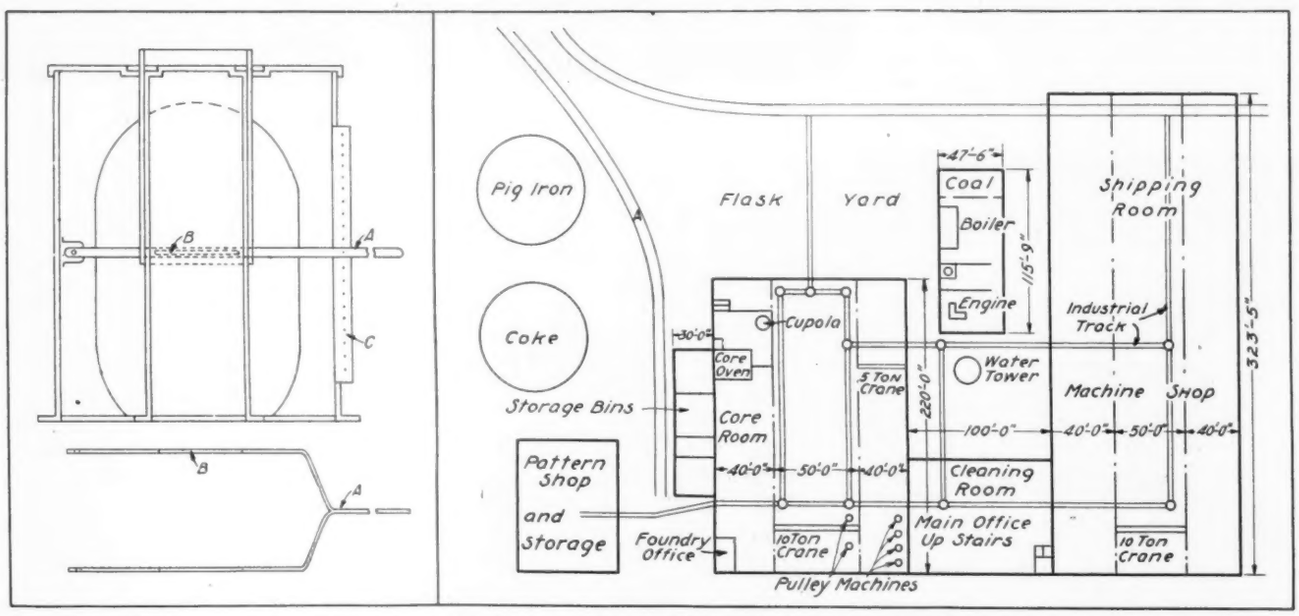


FIG. 7—SECTIONAL VIEW OF MACHINE ON WHICH SMALL PULLEYS ARE MADE. FIG. 8—PLAN OF BUILDINGS OF W. A. JONES CO. SHOWING INDUSTRIAL TRACKS WITH TURNTABLES CONNECTING ALL DEPARTMENTS

Addresses Newark Foundrymen

Dr. Richard Moldenke addressed the Newark Foundrymen's association, at its recent regular monthly meeting in Newark, N. J., on foundry melting processes. He stated that attention to this question is becoming increasingly important, and that in a few years when some of the inferior castings which have been produced under the stress of wartime operations, will be coming into the foundries as scrap, the problem of proper melting will assume a vital aspect. Dr. Moldenke expressed the opinion that the electric furnace would probably form the solution, although the small foundryman at present might possibly find such a process costly.

At the meeting, the following officers were elected for the ensuing year: President, A. E. Barlow, president, Barlow Foundry Inc., Newark; vice president, George Krouse, Jersey City; treasurer, John Campbell, Flockhart Foundry Co.; and secretary, P. A. Smith, P. A. Smith Mfg. Co., Newark.

The Canada Carbide Sales Co., New York, has opened an office at 549 McCormick building, Chicago, with Henry Booth in charge as sales manager. The company sells ferroalloys, carbide and acetic acid.

Electric Furnace for Melting Nonferrous Metals--II

Minimizes Gas and Sulphur Absorption to Give High-Grade Metal
—Statement of Melting Costs for Electric and Fuel-Fired Furnaces

By E F Collins

IN the preceding article electric furnaces were classified according to their principles of heating and discussed in a more or less general fashion. In this article a few types of furnaces will be selected and dealt with specifically, especially as to their power requirements and costs of operation relative to furnaces of the fuel-fired class.

A nonelectrolytic furnace in which heat is developed by the flow of current through a liquid or solid conductor is shown in Fig. 6 of the preceding article. This well known induction type of brass furnace is said to be exceptionally efficient thermally while melting. Its overall working efficiency for the week is not appreciably different from furnaces of the other classes discussed but it must be remembered that kilowatt-hours per ton consumed in melting, by no means, indicates the overall working efficiency. For illustration, suppose that the induction type of furnace has the highest thermal efficiency in melting. A certain furnace of this type, melting a charge of red brass each hour, has a crucible capacity of 400 pounds and a no-load loss or radiation of 8 kilowatts per hour. Suppose the charge is poured at 1300 degrees Cent., and that it is necessary to use preheated hand ladles in pouring. The furnace must be kept hot 24 hours per day when the crucible has once been heated up. Now compare the effective working kilowatt-hours consumption per ton with that of a 2250-pound per hour tilting type furnace of the design described and melting 18,000 pounds of red brass per 8-hour day. It will be noted that this furnace may be charged by machine, whereas, the crucible furnace must be carefully charged by hand. One man's labor will operate, charge and melt this metal at $4.50 per day or $1 per ton for labor. Pouring of the charge will be by preheated hand ladle and should cast the same as pouring a like quantity of the metal from a number of crucibles.

Since five or six 400-pound crucible furnaces must be employed to give the same metal output as one 2250-pound tilting furnace, it seems that labor of charging and melting would cost at least two and one-fourth times as much in a crucible furnace as in a tilting hearth type or $2.25 per ton. Hence, it follows that the accompanying figures hold true under average conditions.

Metal melted per week in 400-lb. crucible induction furnace per 8-hour working day, lbs.	48 x 400 =	19,200
Kilowatt-hours to melt 19,200 lbs. at 200 kilowatt-hours per ton	200 x 9.6 =	1,920
Kilowatt-hours to keep furnace hot while not melting (24 x 7 = 168.168 — 48 = 120 hours per week	120 x 8 =	960
Total kilowatt-hours per week		2,880
Kilowatt-hours per ton	2,880/9.6 =	300
Power cost per ton at $0.01 per kilowatt		$3.00
Estimated excess labor cost of 400-lb. crucible furnace over 2,250-lb. tilting hearth per ton		$1.25
Total		$4.25

This $4.25 is the power cost, which may be allotted per ton to the 2250-pound furnace and still maintain an equal all-week efficiency for the same total amount of metal melted by either furnace. In other words, if the large tilting furnace melts with the expected consumption of 425 kilowatt-hours per ton, it has equalled the performance of the induction crucible furnace, which, off hand, seems much more efficient because we say it melts for 200 kilowatt-hours per ton. Large capacity induction furnaces might change the above somewhat but the writer does not know of any successful design on the market at present for melting brass in a capacity exceeding 600 pounds. In fact, these are limited in their use to certain mixtures only. Leaded brass above 3 per cent fluxes on the crucibles.

The foregoing clearly shows that a furnace should not be selected merely because it melts at a low kilowatt-hour per ton, but all other characteristics should be studied and its overall cost of turning out metal considered when conforming to local conditions, since different working cycles may give widely different overall results.

The writer wishes to call attention to certain characteristics, losses, handicaps, etc., which influence the overall cost of melting and must be con-

Table I

Average Cost of Melting Brass

Furnace type	pit	pit	tilting	pit	reverb.	pit	tilting crucible	crucible		tilting
Furnace draft	natural	forced	forced	natural	natural	forced	forced	burner	burner	electric
Furnace fuel	coke	coke	coke	coal	coal	oil	oil	nat. gas	city gas	electric
Fuel cost price	9.75	9.75	9.75	8.00	8.00	.098 gl.	.098 gl.	.30-M	.60-M	.015 per K.W.H.
Fuel quantity	1400	700	600	1200	900	50 gal.	60 gal.	4800	7000	400 K.W.H.
										10 hrs.
										250 K.W.H.
										24 hrs.
Metal loss	70	30	30	70	124	30	44	40	40	15
Fuel cost	$6.82	$3.41	$2.92	$4.80	$3.60	$4.90	$5.88	$1.44	$4.20	$6.00	$3.75
Zinc val. for 10 lb.	7.00	3.00	3.00	7.00	12.40	3.00	4.40	4.00	4.00	1.50	1.50
Cost reclaiming	.50	.50	.50	.50	.50	.50	.50	.50	.50	.15	.15
Ren. and repairs	.40	.40	.35	.40	.50	.50	.50	.35	.30	1.00	1.00
Cost preheating crucible	.40	.40	.40	.40	.40	.40	.10	.40	.40	.10	.10
Furnace labor	2.25	2.25	2.25	2.25	1.50	2.25	1.50	2.25	2.25	1.00	1.00
Misc. and labor and fuel	.50	.50	.50	.50	.50	.40	.40	.40	.40	.20	.20
Cost charcoal	.12	.12	.12	.12	.12	.12	.12	.12	.12	.05	.05
Air for blast	...	.15	.15	...	...	.15	.15	.15	.15	...	...
Crucible cost	5.00	5.50	5.50	5.00	...	8.00	...	8.00	8.00	...	...
Int. crucible stk.	.10	.10	.10	.10	...	.10	...	.10	.10	...	...
Lining—Pouring crucible	...	...	.30	...	.30	...	.30	.30	.30	.30	.30
Electrodes & coke	...	...	...	...	...	...	...	...	...	.60	.60
Cost per ton total	$23.09	$16.33	$16.09	$21.07	$19.82	$20.32	$13.85	$18.01	$20.72	$10.90	$8.65

Table II

Analysis of Metal Losses Relative to Pouring Temperature

Yellow brass, Copper, lbs.	Yellow brass, Zinc, lbs.	Temperature of alloying, deg. Cent.	Pouring temperature, deg. Cent.	Alloy recovered, lbs.	Zinc loss, per cent	Metal loss per cent
420	180	1170	1150	565	19.0	5.8
420	180	1100	1100	590	5.6	1.6

Table III

Chemical Analysis of Metal Losses Relative to Pouring Temperature

Yellow brass, per cent Copper	Zinc	Temperature of alloying, deg. Cent.	Pouring temperature, deg. Cent.	Alloy recovered, per cent, Copper	Zinc	Zinc loss, per cent	Metal loss, per cent
70	30	1170	1150	75.9	24.1	24.0	7.3
70	30	1100	1100	71.3	28.7	5.5	1.6

sidered in making up true melting costs. These will now be considered and their effect shown upon costs as tabulated in Table I. In this table is shown the cost per ton of making red brass using 10 per cent or less zinc and pouring at 1300 degrees Cent. In the preceding article it was shown that conditions are under absolute control in the case of the electric furnace, whereas in the fuel-fired furnace, the control of temperature is usually not so accurate. Large volumes of gas of combustion must pass through the furnace and likewise, since heat is generated through oxidization of fuels the furnace chamber cannot be free from oxidizing influences upon the metal.

Metal Losses and Their Causes

In a given electric furnace, the pounds of metal lost in melting increases as the temperature for forming the alloy lies above the melting point of the alloy. To illustrate how the lack of temperature control may increase the metal losses in melting brass, the following test is given. In the electric furnace 70-30 brass is made by melting down 420 pounds of copper, adding 180 pounds of zinc at 1170 degrees Cent., and pouring at 1150 degrees Cent. In this experiment 420 pounds of copper were melted down, 180 pounds of zinc were added at 1100 degrees Cent., and pouring was made at 1100 degrees Cent., with the results as shown in Table II. The chemical analysis of the same test is shown in Table III. These results showing the effect of temperature on yellow brass are consistent with the melting and boiling curves shown in Fig. 7. By following the pouring temperature curve as shown, excessive metal melting loss in the electric furnace will be avoided. Losses can be decreased by keeping well under this curve. Hence, it is seen that the melting loss in the electric furnace, may be easily controlled by observing this alloying and pouring temperature. The pounds of metal lost in melting is independent of the charge in a given electric furnace free from ventilation. A few figures are shown as follows:

Metal melted, lbs.	Charge, lbs.	Temperature of melt, deg. Cent.	—Metal loss— per cent	lbs.
2,696	674	1,100	1.4	37.6
3,727	932	1,200	1.3	38.4

In the fuel-fired furnace the magnitude of the loss from this source is influenced by the speed of melting and the volume and velocity of gases flowing over the melting metal; increasing the atmospheric pressure in the furnace and decreasing the volume and velocity of the gases tend to reduce volatilization loss. For each fuel there is a maximum limit to gas speed or velocity through the furnace, since each fuel in developing the required heat units necessary for a given speed, must develop a certain volume of gases which must pass out. Hence, proper gas velocity is inseparably connected with products of combustion from various fuels. The approximate volume of flue gases in coal, coke and oil furnaces averages from 3350 to 5800 cubic feet per 100 pounds of metal melted. It is easy, therefore, to see how the flow of gas may bring about a large volatile

Table IV

Nonferrous Metals Melted in the Electric Furnace

Metal	Condition of metal charged	State of metal after melting	KW hrs. per ton to melt	Metal loss in melting, per cent
Copper	Electrolytic cathode Pig Scrap, heavy Scrap, light Scrap, dirty Chips, oily Chips, clean	Pig at pitch without rabbling or poling Wire bar Foundry castings	300 to 500	No oxidation; a certain amount of copper oxide is reduced.
Zinc	Electrolytic cathode Pig Punchings Chips Heavy scrap	Pig Foundry castings Billets for rolling Battery electrodes	90 to 120	Dross and oxidation under 2
Nickel	Shot Bar Scrap	Pig Foundry castings Billets for rolling	500 to 750	No oxidation loss
Aluminum	Pig Scrap Punchings Turnings	Pig Foundry castings Billets for rolling	400 to 750	Less than 1 oxidation
Tin	Bar Pig Scrap	Bar Pig Wire	40 to 60	No oxidation
Lead	Pig Scrap Sheet	Billets for rolling Casting Pig	20 to 40	No oxidation

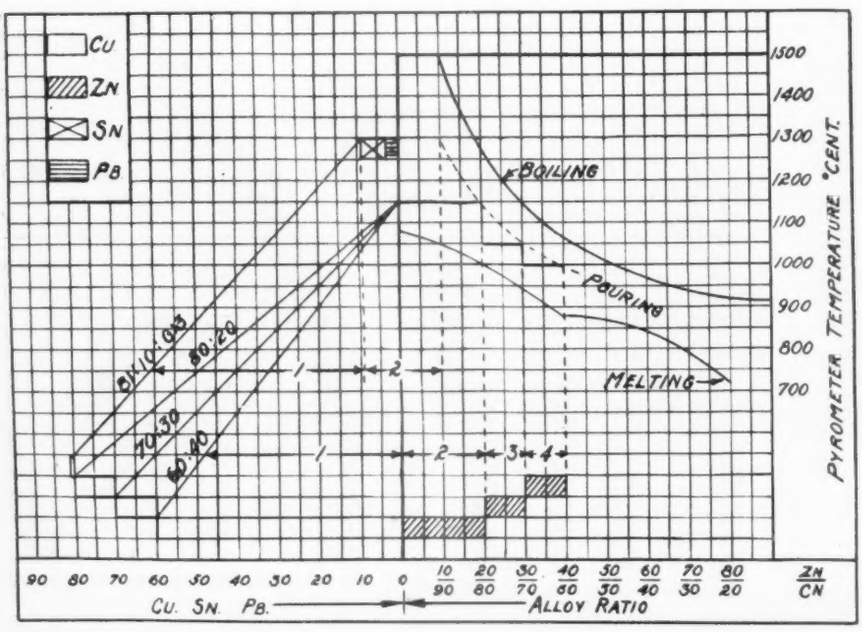


FIG. 7—MELTING, BOILING AND POURING CURVES WHICH INDICATE HOW SPELTER MAY BE CONSERVED IN MAKING YELLOW BRASS

loss in the fuel-fired furnace. In the electric furnace the gas flow is very small and consequently, though its atmosphere is saturated with metal vapors, so little gas leaves the furnace during a melt that the resulting loss is negligible. Copper, zinc, tin and lead, the constituents of commercial brasses, are all very readily oxidized at the temperatures to which they must be heated for melting and pouring. Oxidizing results in loss of metal, actually burning the metal to a dross. A neutral or reducing atmosphere in the electric furnace can be maintained readily but it is certain that carbon monoxide must be so high and oxygen so low in ordinary fuel furnaces, that a reducing atmosphere cannot be maintained without sacrificing heat units through burning carbon to carbon monoxide instead of carbon dioxide.

Gas absorbtion is directly proportional to the temperature and the length of time metal is held in contact with gases. Incidental and intimately related to oxidation of metal is the absorption of gases. In melting the constituents of an alloy, a gas may enter into chemical union with some of the metals to form oxides or it may be occluded in the alloy. As an illustration, when silver is molten (1020 degrees Cent.) it can absorb about 20 times its own volume of oxygen. On cooling it gives up the oxygen absorbed as evidenced by the well known spitting of silver on freezing. Absorption of gases is greater as the temperature increases. When metals freeze, absorbed or dissolved gases are given up, but if these gases do not pass from the metal while freezing, sponginess and blow holes will be produced in the alloy. This same effect may be produced by air trapped in pouring and by gases evolved by molds or cores when hot metal enters them, but dissolved gas in the metal is unquestionably a principal source of porosity and blow holes. All fuels used in the foundry at the present time contains some degree of sulphur which is a very common source of trouble. In Fig. 8 is illustrated the effect of gas absorption on a copper wire bar. The lower bar is shown at pitch and presents smooth surfaces on all sides. Chemical contents of this copper are: Copper, 99.87 per cent; oxygen, 0.084 per cent; and sulphur, 0.0022 per cent. When made into wire of No. 12 gage it has a conductivity of 99.3 per cent, a tensile strength of 65,207 pounds per square inch and an elongation in 10 inches of 13 per cent. The bar shown above the illustration is made from the same metal as that below but a quantity of gas was absorbed with the result that the top and sides of the bar are rough and blistered. Melted brass absorbs sulphur greedily and gives it up upon cooling in the sand molds, thus causing porosity and blow holes. One successful brass foundryman asserts that many of the failures usually attributed to oxygen are really due to sulphur. With most careful crucible melting in a coke-fired furnace, the metal will absorb 0.002 to 0.005 per cent of sulphur. Sulphur accumulates in a metal each time it is melted which accounts for the dark skin of rerun castings as compared to first melt metal. In fact, even though melted under a charcoal cover and carbon monoxide blanket, copper needs a deoxidizer to free it completely from oxygen. The foregoing trouble should not occur in connec-

Table VI

Alloys Made in the Electric Furnace

Alloy	Condition of alloy charged	State of alloy after melting	KW hrs. per ton	—Alloy— Loss, per cent	—Alloy— Temp., deg. Cent.
Red brass.....	Yellow brass and copper or red brass and zinc, pig scrap and sprues, turnings and chips....	Foundry castings .... Wire bar ..... Billets	225 to 300	0.15 to 0.50	1300
Yellow brass...	Red brass and zinc or yellow brass and zinc, pig scrap sprues turnings and chips.....	Foundry castings .... Wire bar ..... Billets	200 to 275	0.40 to 1.00	1100
Copper nickel...	Scrap and billets.....	Foundry castings .... Billets	500 to 750	*	1600
Nickel silver...	Copper sprues, scrap nickel, virgin metal zinc.....	Foundry castings .... Billets for drawing and rolling	500 to 750	†	1650

*No oxidation.
†Zinc loss 2 out of 32 per cent.

Table V

Nonferrous Alloys Made in the Electric Furnace

Metals, per cent	Condition of metal charged	State of alloy after melting	KW hrs. per ton	Metal loss, per cent
Red brass:—				
Cu. 80.0 Zn. 10.0 Sn. 6.0 Pb. 4.0	Scrap pig, electrolytic cathodes Scrap, bar ..... Scrap, pig	Foundry castings..... Wire bar ..... Billets	250 to 400	0.25 to 0.7 Depending upon manipulation of furnace
Yellow brass:—				
Cu. 60.0 Zn. 39.5 Pb. 0.5	Scrap, pig, electrolytic cathodes Scrap pig	Foundry castings..... Wire bar ..... Billets for rolling....	220 to 350	0.50 to 1.5

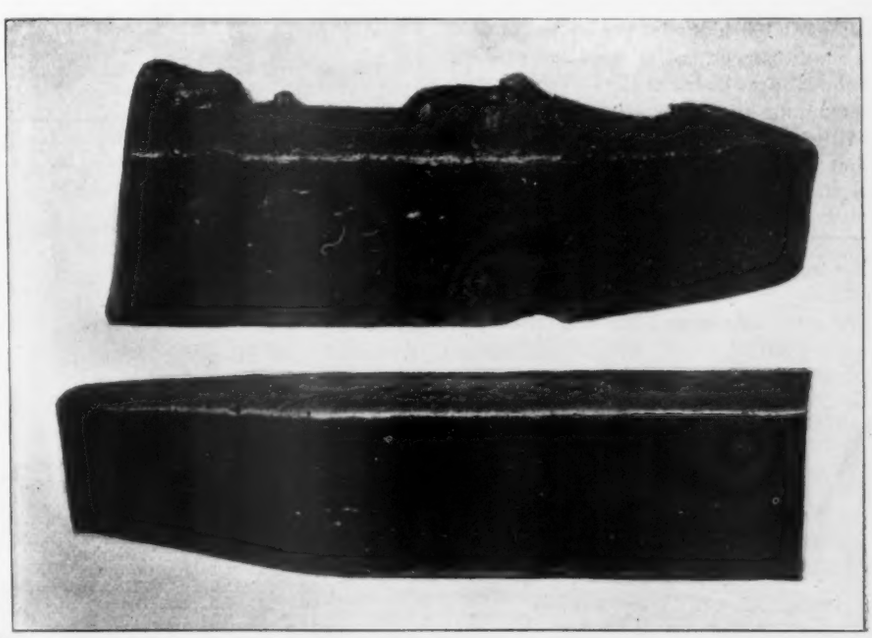


FIG. 8—COPPER WIRE BARS SHOWING THE EFFECT OF GAS ABSORPTION. BOTH BARS ARE MADE FROM THE SAME METAL

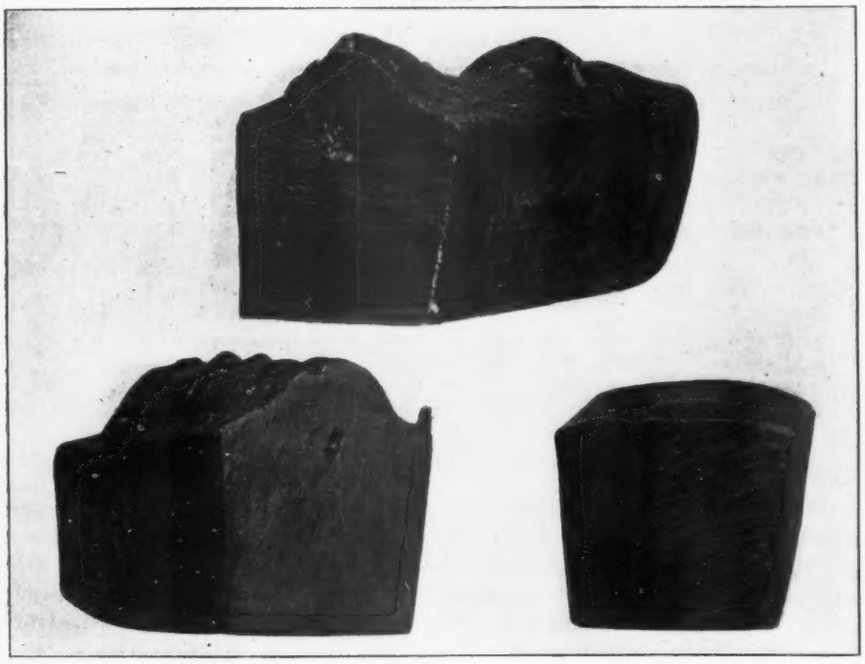


FIG. 9—SPECIMENS OF COPPER TO SHOW THE EFFECT OF SULPHUR ABSORPTION. NOTICE THE ROUGH SURFACE OF TWO OF THE BARS

tion with electric melting since the furnace chamber may be kept uncontaminated and free from oxygen and injurious gases. In Fig. 9 is shown the effect of sulphur on copper. The bar shown to the lower right is free from this effect and has a content of copper 99.902 per cent, oxygen 0.073 per cent and sulphur 0.002 per cent. Above and to the left of this bar are shown bars which have absorbed sulphur with the result that the bars resemble those affected by gas absorbtion. Loss of zinc is proportional to the temperature and length of time the metal is held at the high temperature. This statement means that if one charge is melted at the rate of 100 pounds per hour and a second charge at the rate of 200 pounds per hour, with all conditions remaining the same, the melting loss of the second charge will be less than that of the first charge. Electric methods of melting tend to quick melting and high melting rates. Melting rates are: 1500 pounds in one hour, electrically; 1500 pounds in 2¼ hours, fuel-fired; 600 pounds in ½ hour, electrically; and 600 pounds in 3 hours, fuel-fired.

Metal loss in melting is ordinarily best judged from the chemical analysis of the metal charged. This test eliminates errors arising from furnace wall absorption or the reverse and also losses in pouring. To show the inconsistency of the actual recovery method of loss-test, the results of comparative tests on a coal-fired crucible furnace of 250 pounds capacity and an electric furnace of 1500 pounds capacity are presented. The metal was poured from the crucible direct whereas an auxiliary ladle was used to pour from the 1500-pound electric furnace, thus giving chance for more loss in pouring. The metal recovery test on red brass is tabulated as follows:

Metal charged, lbs.	Metal recovered, lbs.	Loss per cent	Type of furnace
1500—1 heat	1465	2.33	Electric tilting
1500—1 heat	1484	1.07	Electric tilting
250—4 heats	980	2.00	Coal-fired crucible
250—4 heats	990	0.85	Coal-fired crucible

The chemical analysis for the melting loss on the same electric furnace and the same metal showed approximately 0.4 per cent zinc loss. Physical contents of the metal charged and the metal poured are very similar by the electric furnace method as shown:

	Per cent				
	Sn.	Pb.	Cu.	Zn.	Fe.
Analysis of metal charged	4.30	6.55	80.88	8.02	0.25
Analysis of metal poured	4.29	6.60	81.46	7.61	0.25

An actual test on yellow brass in the electric furnace showed a loss of 1.6 per cent with 600 pounds of metal charged and 590 pounds poured. The analysis showed that of the metal charged, copper 70 per cent and zinc 30 per cent, the metal poured had a content of copper 71.3 per cent and zinc 28.6 per cent with a loss of 1.4 per cent. In a test of melting phosphor-bronze in the electric furnace, 2696 pounds of metal were

Table VIII

Cost Per Ton of Making Yellow Brass

(Compiled by E. F. Collins)

								350 K.W.H. 10-hr. day	220 K.W.H. 24-hr. day
Fuel quantity, lbs.	1000	600	400	700	400	40 gal.	45 gal.	...	...
Metal loss, lbs.	100	40	56	100	200	60	70	30	...
Fuel cost	$4.88	$2.92	$1.95	$2.80	$1.60	$3.92	$4.41	$5.25	$3.30
Zinc value for 10 lb.	10.00	4.00	5.60	10.00	20.00	6.00	7.00	3.00	3.00
Cost reclaiming	.50	.50	.50	.50	.50	.50	.50	.15	.15
Renewal and repairs	.40	.40	.35	.40	.50	.50	.75	1.00	1.00
Cost preheating crucible	.40	.40	.40	.40	.40	.40	.10	.10	.10
Furnace labor	2.25	2.25	2.25	2.25	1.50	2.25	1.50	1.00	1.00
Miscellaneous labor and fuel	.50	.50	.50	.50	.50	.40	.40	.20	.20
Cost charcoal	.12	.12	.12	.12	.12	.12	.12	.05	.05
Air for blast	...	.15	.15	...	...	.15	.15	...	...
Crucible cost	4.50	5.00	5.00	4.50	....	4.50	....	....	....
Interest—crucible stock	.10	.10	.10	.10	...	.10	...	...	...
Lining pouring crucible	...	...	.30	...	.30	...	.30	.30	.30
Electrodes and coke	...	...	...	...	...	...	...	.60	.60
Cost per ton Total	$23.65	$16.34	$17.22	$21.57	$25.42	$18.84	$15.23	$11.65	$9.70

Table VII

Average Melting Results With Fuel Fired Furnaces

Compiled by E. F. Collins

Type	Furnace Draft	Fuel Kind	Per ton	Metal loss per cent	Metal melted
Pit	Natural	Coke	1400 lbs.	3.5	Red brass
			1000 "	5.0	Yellow brass
Pit	Forced	Coke	700 "	1.5	Red brass
			600 "	2.0	Yellow brass
Tilting	Forced	Coke	600 "	1.5	Red brass
			400 "	2.8	Yellow brass
Pit	Natural	Coal	1200 "	3.5	Red brass
			700 "	5.0	Yellow brass
Reverberatory	Natural	Coal	900 "	6.2	Red brass
			400 "	10.0	Yellow brass
Pit	Bumers tangential	Oil	50 gal.	1.5	Red brass
			40 "	3.0	Yellow brass
Tilting	Open flame atomizing bumer	Oil	60 "	2.2	Red brass
			45 "	3.5	Yellow brass
Tilting crucible	Bumers tangential	Artificial gas	4800 cu. ft.	2.75	Yellow brass
Tilting crucible	Bumers tangential	Natural gas	7000 "	2.75	Yellow brass

charged and 2656 pounds were poured at 1100 degrees Cent., with a loss of 1.4 per cent. Another trial showed that of 3727 pounds charged, 3678 pounds were poured at 1200 degrees Cent., with a loss of 1.3 per cent. An electric furnace and an open flame oil furnace melted the same kind of brass and a physical test of the metal resulted as follows:

	Electric furnace	Oil furnace
Tensile strength, lbs. per sq. in..	27,900	24,969
Yield point, lbs. per sq. in.....	10,844	9,850
Elastic limit, lbs. per sq. in.....	7,300	7,000
Elongation in 2 in., per cent....	19.4	16.9
Elongation in 8 in., per cent....	17.2	14.9
Reduction area, per cent.....	21.4	19.7

In a similar test with brass in an electric furnace and a crucible furnace the results were:

	Electric furnace	Crucible furnace
Tensile strength, lbs. per sq. in..	30,820	30,250
Elastic limit, lbs. per sq. in....	17,833	18,000
Elongation, per cent.....	16.14	19.37
Reduction of area, per cent.....	16.10	22.00

Tables IV, V and VI show the average performance to be expected from the use of the electric furnace with the furnace charge in several different forms. In Table VII are shown similar results for other furnaces. The results given in Tables II to VI are average figures and may be influenced to meet any particular foundry by the promptness of pouring; the temperature of the metal since pyrometers are seldom used, local conditions such as physical condition of metal charged, its cleanliness, volume of air and products of combustion which pass through the furnace in the natural draft furnaces which vary from day to day; the design of the furnace; the manipulation of the furnace; the size of the crucible; the percentages of composition; the length of working day; whether observations are based on a hot furnace and hot crucibles or whether the first heat of the day is excluded; pouring light castings requiring hot metal and heavy ones requiring metal at a lower temperature and whether results are from careful tests or whether they represent actual foundry or rolling mill practice and extend over a considerable period. In Fig. 10 is illustrated graphically how a furnace capable of turning out metals for 300 kilowatt-hours per ton, due to foundry handicaps averages 350 kilowatt-hours per ton. This furnace has a hearth capacity of 2000 pounds and a melting rate of 1700 pounds per hour. Dirt skimmed from the furnace averages 107 pounds per ton. During the period over which these tests extended, no relining or patching of the furnace was done.

Table VIII is presented as a resume of that which precedes it in this article, relating to the cost of melting brass per ton with the various typical fuel-fired furnaces and also with the electric brass melting furnace, based on the author's experiments, observation and researches. This table is an average but results for individual foundries may be found readily by substituting in the itemized costs those which obtain there, for instance, 1.5 cents per kilowatt-hour has been used as electrical power cost, but should this be 1 cent in the plant under consideration, this figure should be substituted. Likewise other values may be converted to actual ones for an actual local condition.

Elementary Points on Core-Making

By M. H. Potter

Many casting losses in the foundry can be attributed to coreroom practice. Green sand surfaces of a mold allow gases from the cooling metal and steam generated in the sand to escape. Any steam or gases formed within the core, however, must be given free passage through the core to the atmosphere or a blow-hole will be formed, ruining the work.

Core sand must, therefore, have greater porosity than that required for the mold. Small cores should be made from clay free sand. In making large cores a portion of molding sand is added to strengthen the core body. About 1/3 of the core mixture for large work may be molding sand of coarse structure. A sand which possesses round, uniform-sized grains and cannot be packed together sufficiently to close up the spaces between is the most desirable. Such a sand cannot be held together without an added binding material. The binder should be sufficiently adhesive that little is required. Too much binder fills the interstices between the grains. Naturally, the finer the grain size of the sand the smoother will be the surface left by the core. A binder must have adhesive properties. In drying it must cement the sand grains together if the desired results are to be obtained. The binder must not draw to the skin leaving a weak center.

Some binders tend to draw moisture from the air after baking. Pitches and rosin are particularly good for many classes of cores and will not absorb moisture readily, but they give trouble in the cleaning room. Mixtures with a linseed oil base give satisfactory results if properly baked.

A good core should stand up well enough in the green state to enable it to be handled previous to baking. It should not swell or crack during baking, or soften and deform in storage within a reasonable time. Further, it should not soften, deform, or cause reaction in the mold, after the metal has been poured and before the casting has had time to set. However, the core should crush and disintegrate easily after the casting has cooled.

Baking involves two distinct steps. The initial heating dries the core, driving out the moisture. The second or baking stage gives the core the desired strength, and removes those components which cause reaction when the molten metal touches it. Evaporation of the water, which is the first stage in baking, requires time, but after this has been accomplished the baking itself is not a long process. When the cores become dry they should be put into the upper part of the oven where the temperature is higher. If too high a temperature is maintained to secure quicker results, the cores must be removed promptly when cured to avoid over-baking. Burnt, and therefore weak cores, result if care is not taken both in regard to the temperature maintained and the time allowed.

Cores should not be set unless the mold is to be poured the same day. Molds which have been closed and are not poured off at once should be opened the following morning to examine the cores for moisture. Moisture is re-absorbed readily from contact with the green-sand mold.

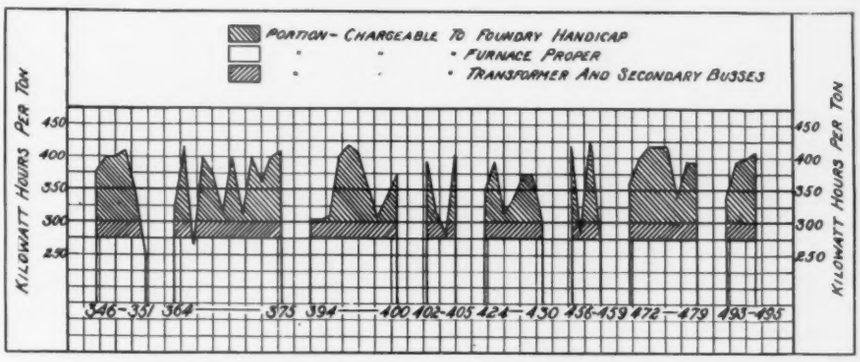


FIG. 10—CHART SHOWING HOW FOUNDRY HANDICAPS PREVENT THE ELECTRIC FURNACE FROM MAKING RED BRASS ON MINIMUM POWER CONSUMPTION

Steel Foundry Opened in Wilkes-Barre, Pa.

Engineering Skill and Foundry Experience Utilized in Steel-Casting Shop—One 20-Ton Open-Hearth Furnace Now Installed

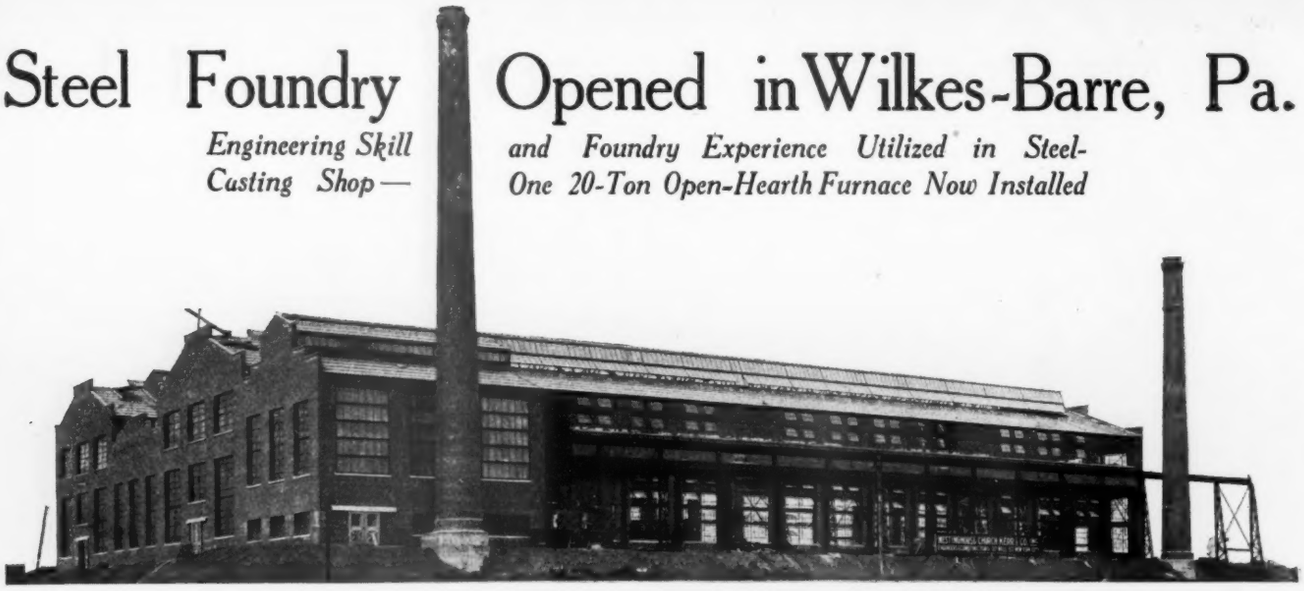


Fig. 1—The Foundry is of Steel and Glass Construction with Two Tall Brick Chimneys, One for the Open-hearth Furnace and the Other for the Annealing Pit

THE Vulcan Iron Works, Wilkes-Barre, Pa., has recently placed a new open-hearth steel foundry in operation in order to take care of the steel casting requirements of the three plants of the company, which are located at Wilkes-Barre and West Pittston, Pa. Before the foundry was designed, a careful study was made of the company's present and future needs for steel castings so that the plant as it stands today is the result of a combination of engineering and practical foundry experience.

The building has been so designed and located with respect to future construction that its capacity may be increased and extensions made without disturbing the production operations or relocating any of the equipment at present installed. The foundry is built of brick throughout, with structural - steel framework, steel sash and cement-tile roof. The general plan, as shown in Fig. 2, is L-shaped. The building consists of three parallel main bays, running north and south. The foundry yard in which scrap and other materials are stored is located east of the main foundry bay. It is served throughout its entire length by a 10-ton traveling crane. This crane runs into the furnace house and serves the charging floor.

There is one 20-ton open-hearth furnace which is oil fired but has been so constructed that producer gas may be used at some future time. It is provided with a radial brick stack 4 feet inside diameter and 125 feet high. A view of the furnace is shown in Fig. 3.

This furnace is located in a furnace house on the east side of the casting floor at the south end of the main bay. The furnace house is 50 feet wide and 60 feet long. The structural steel has been so designed that this building may be extended to the north and an additional open-hearth furnace installed. All the steel work for the charging floor also has been designed so that the supports are strong enough to support a charging machine should it become necessary or desirable to install one at some future time. The dry-sand molding floor, which is located in the west bay, is 70 feet wide by 180 feet long. It is served throughout by one 10-ton and one 20-ton traveling crane and one 5-ton traveling wall crane located along the easterly line of columns. An 8-foot pan-mill and a 60 x 84-inch molding machine are located in this department.

The sand bins have been placed directly west of the dry-sand molding floor and are at present 80 feet long, but provisions has been made in the construction so that the bins may be extended the full length of the building. The sand is brought to the plant in cars and delivered to a track hopper from which it is carried to the sand bins by means of a bucket elevator and belt conveyor. A pit has been provided at the pan-mill so that the sand may be discharged directly into a bucket which is picked up by the molding floor cranes and delivered to any point desired. This arrangement admits of the rapid handling of

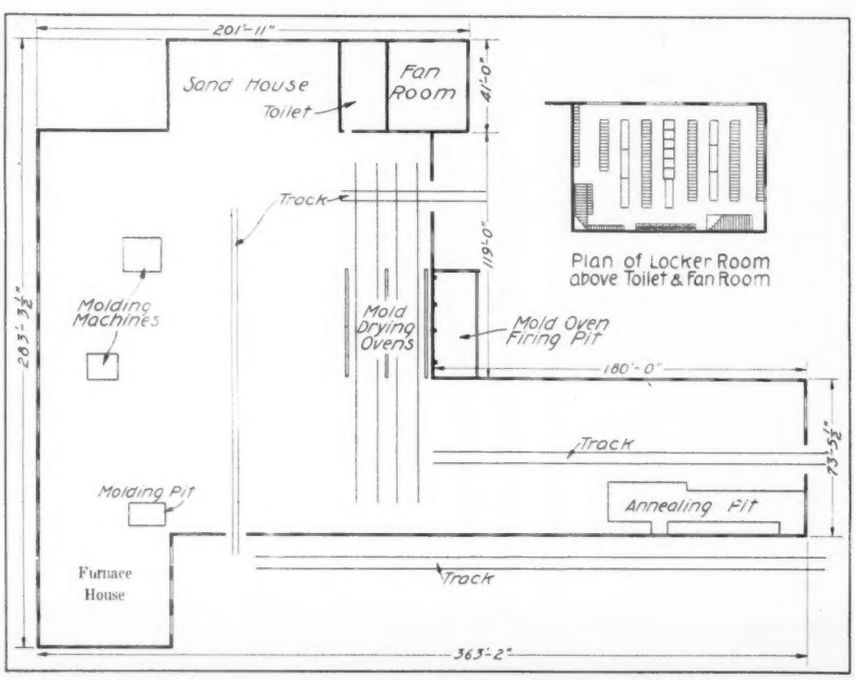


FIG. 2—PLAN OF FOUNDRY SHOWING LOCATION OF FURNACE WITH REFERENCE TO MOLDING AND POURING-OFF FLOORS

molding sand with a minimum of manual labor. The completed molds are delivered to the drying oven cars by means of the molding-floor overhead cranes.

The drying ovens are located in the center bay, which is 50 feet wide and 180 feet long. This bay is served by a 10-ton traveling crane. The drying ovens are located at the north end of this bay. They are of the double-ended type, that is, the molds are delivered to the drying-ovens from the molding floor and taken out on the casting floor through the ovens. There are two ovens; each oven is 20 feet wide, 48 feet long and 12 feet high, inside dimensions. These ovens are so arranged that each one may be separated into two compartments, each compartment being 24 feet long. This division permits of the heating of only half an oven in cases where smaller molds are dried, thus saving considerable fuel. The drying-ovens are fired with coal, from a firing pit conveniently located. This firing pit is at present outside the building in a small lean-to. In the case of a future extension, additional drying ovens will be located north of the firing pit so that they may all be fired from one point. The drying ovens are of the sand-sealed type and are provided with both a forced draft and an exhaust system, by means of which close regulation of temperature may be obtained.

The core ovens have been located directly south of the drying ovens, one being of the car type and one of the drawer type. They are so arranged that they may be fired by either coal or oil fuel. The remaining portion of the center bay is taken up by the core and green-sand molding departments. The green-sand molding department is provided with a 40 x 56-inch molding machine.

The main bay of the foundry, which contains the casting floor, the shaking-out floor and the cleaning departments, is 70 feet wide and 360 feet long. It is served throughout by one 40-ton and one 20-ton traveling crane. Provision also has been made for a 5-ton traveling wall crane to be located along the westerly line of columns. The casting pit has been located in the southeast section of the casting floor.

The annealing pits are located in the northeast corner of the main bay. They include one pit 8 feet wide by 40 feet long and one pit 15 feet square. Both of the annealing pits are coal fired. They are provided with an underground flue leading to a radial brick stack. These annealing pits have been so located that when it becomes necessary to extend the cleaning department it will be located north of the pits.

From the general arrangement it will be noted that the work travels in one general direction without cross movements, the molds traveling from the west to the east, the dry molds through the drying ovens and the green-sand molds direct to the casting floor. After a heat has been taken off and the castings shaken out, the flasks may be returned to the molding floor or to the flask-storage yard, the sand loaded into cars by means of a grab bucket and the castings sent directly to the annealing pit.

A power house has been provided containing four 150-horsepower boilers, built by the Vulcan Iron Works, one 250 kilowatt steam-driven alternating-current generator, one air compressor with a capacity of 200 cubic feet per minute, and one 150 kilowatt motor-generator set.

Like the other buildings the power house has been designed with a view to expansion, and when necessary may be enlarged to care for the increased demands of the shop.

Toilet and locker-room facilities are provided in a 2-story lean-to located northwest of the dry-molding floor. The second floor of the building comprises the wash and locker rooms and the first floor is used for the toilet room and the heating and ventilating plant.

Underground ducts have been installed so that an indirect heating and ventilating system may be provided at any time without interrupting foundry operations. With the installation of this indirect system positive ventilation will be assured both winter and summer.

The new plant was designed and constructed by Westinghouse, Church, Kerr & Co., Inc., New York, in conjunction with S. T. Nicholson, president of the Vulcan Iron Work; C. A. Jackson, general superintendent and B. L. Weaver, steel foundry superintendent.

FIG. 3—VIEW OF 20-TON OPEN-HEARTH FURNACE IN COURSE OF CONSTRUCTION

Stove Manufacturers Discuss Export Problems

New methods of shop management and selling practices in keeping with the new era in which industry is now entering were presented at the annual meeting of the National Association of Stove Manufacturers held at the Hotel Astor, New York City, on May 14 and 15. Among the papers on the various phases of these problems were: "Foreign Trade," by Allan Walker, manager of the foreign trade bureau of the Guaranty Trust Co., New York City; the "Commodity or Stabilized Dollar," by H. F. Arens, Babson statistical organization, Wellesley Hills, Mass.; "Service with Profit," by C. E. Knoeppel, C. E. Knoeppel & Co., New York City; "Costs," by L. H. Booch, Bridge & Beach Mfg. Co., St. Louis, and "Business or Commercial Morality," by John Walsh, ex-counsel of the federal trade commission.

Considerable interest was displayed in the foreign trade problem, and a committee was appointed to investigate the advisability of forming an export combination of stove manufacturers under the Webb act. The committee is as follows: J. W. Myers, Union Stove Works, New York City; R. M. Leach, Weir Stove Works, Taunton, Mass.; Horace E. Campbell, Reading Stove Works, Reading, Pa.; L. H. Booch, Bridge & Beach Mfg. Co., St. Louis, and A. J. Lindemann, A. J. Lindemann & Hoverson Co., Milwaukee.

The following officers were elected to head the association for the ensuing year: President, Lee W. Van Cleave, Buck's Stove & Range Co., St. Louis; vice presidents, R. M. Leach, Weir Stove Works, Taunton, Mass., and B. E. MacCarthy, Phillips & Bettendorf Mfg. Co., St. Louis; treasurer, Walter Jones, Richmond Stove Works, Richmond, Va., and secretary, Robert S. Wood.

Making Castings Used in Ship Construction--III

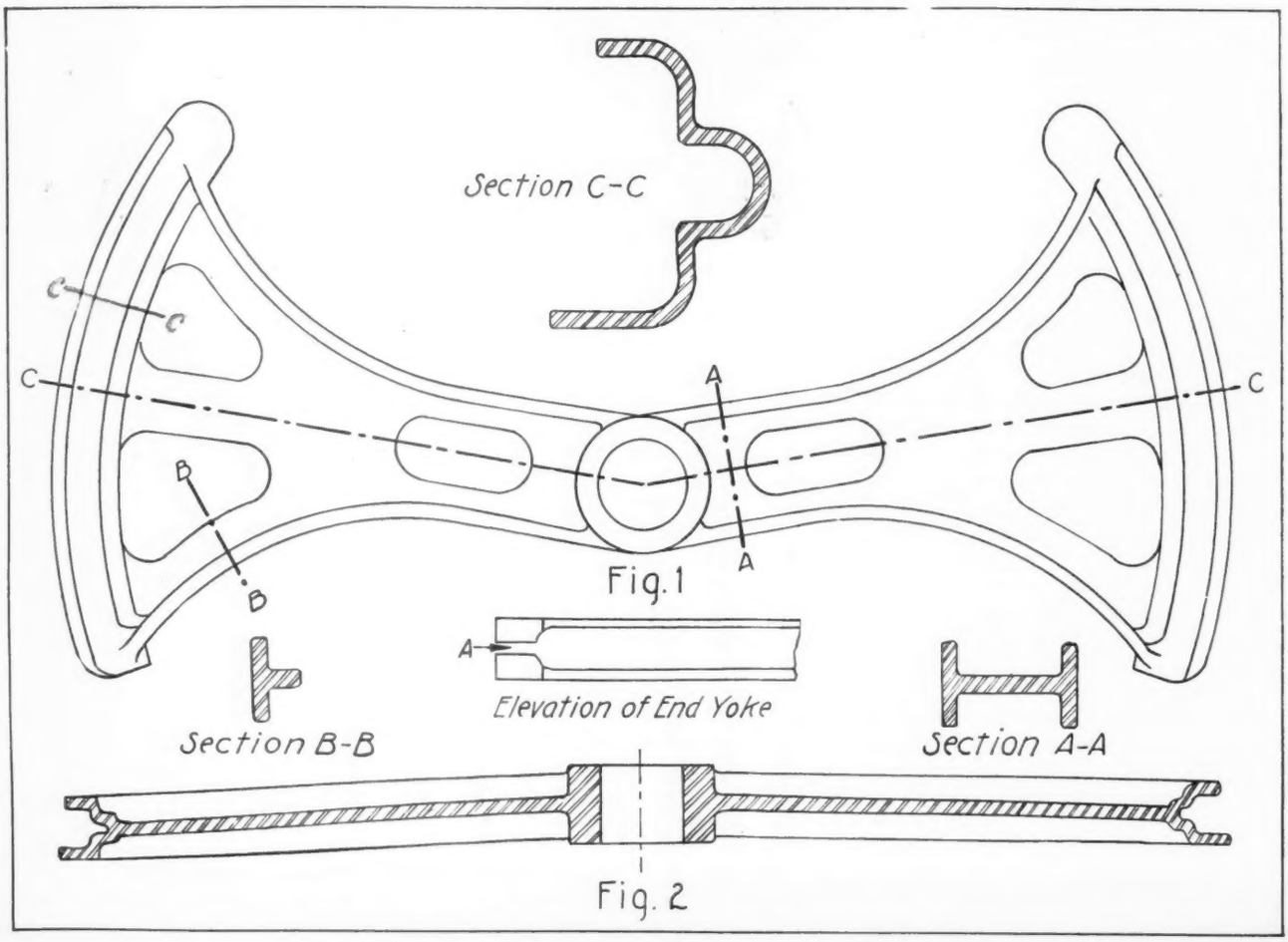
Building the Rudder Yoke Pattern is Not an Involved Operation, Yet it Requires Great Care to Obviate Subsequent Foundry Difficulties

By Ben Shaw and James Edgar

SEVERAL contrivances are used on board ship for controlling rudders, and Figs. 1 and 2 show a representative type of a common form. It is the yoke adopted by the United States navy and many British companies, although the quadrant is popular. The difference between the quadrant and the form shown, is that the quadrant is controlled by an endless chain instead of by two chains secured by a pin through the ends of the chain groove. There is another method of control by means of a square block. This, however, is a forging and consequently is outside the scope of this article. **One great disadvantage** of this double-ended yoke is that it takes up considerable room on the top deck and always is in the way; another suggested disadvantage is that there is always a certain slackness on the chain which has to be taken up before the rudder answers to the wheel. In practice, however, it is found to be satisfactory and if anything goes wrong it can be more easily examined, being on the top deck, than if it were between decks. The outer chain grooves occasionally are stepped-down from the level of the boss and sometimes the angle from the center to the outside is much greater than in the one shown. But these variations do not materially affect either the pattern-making or molding.

This is one of the patterns which cannot be made absolutely rigid. By careful construction and supporting battens, a fair degree of rigidity may be obtained but much depends on the setting of the pattern in the foundry. If the work is properly and carefully built in the pattern shop, even if it yields considerably in transit to the foundry, it will resume its normal and correct form when placed on the prepared bed. But if it is carelessly built and does not lie close on the pattern shop floor, it will cause trouble in the foundry and reliance will have to be placed on weights for keeping it correct. It is a mistake, when building work on a level floor, for patternmakers to rely upon screws for pulling down a warped flange or a base plate, because in the majority of cases unless it is well held, when the work has been built and the screws are taken out, the flange or plate will resume its former shape and cause endless trouble in the foundry and probably an inaccurate casting for which the foundry will be blamed.

A template is not usually supplied

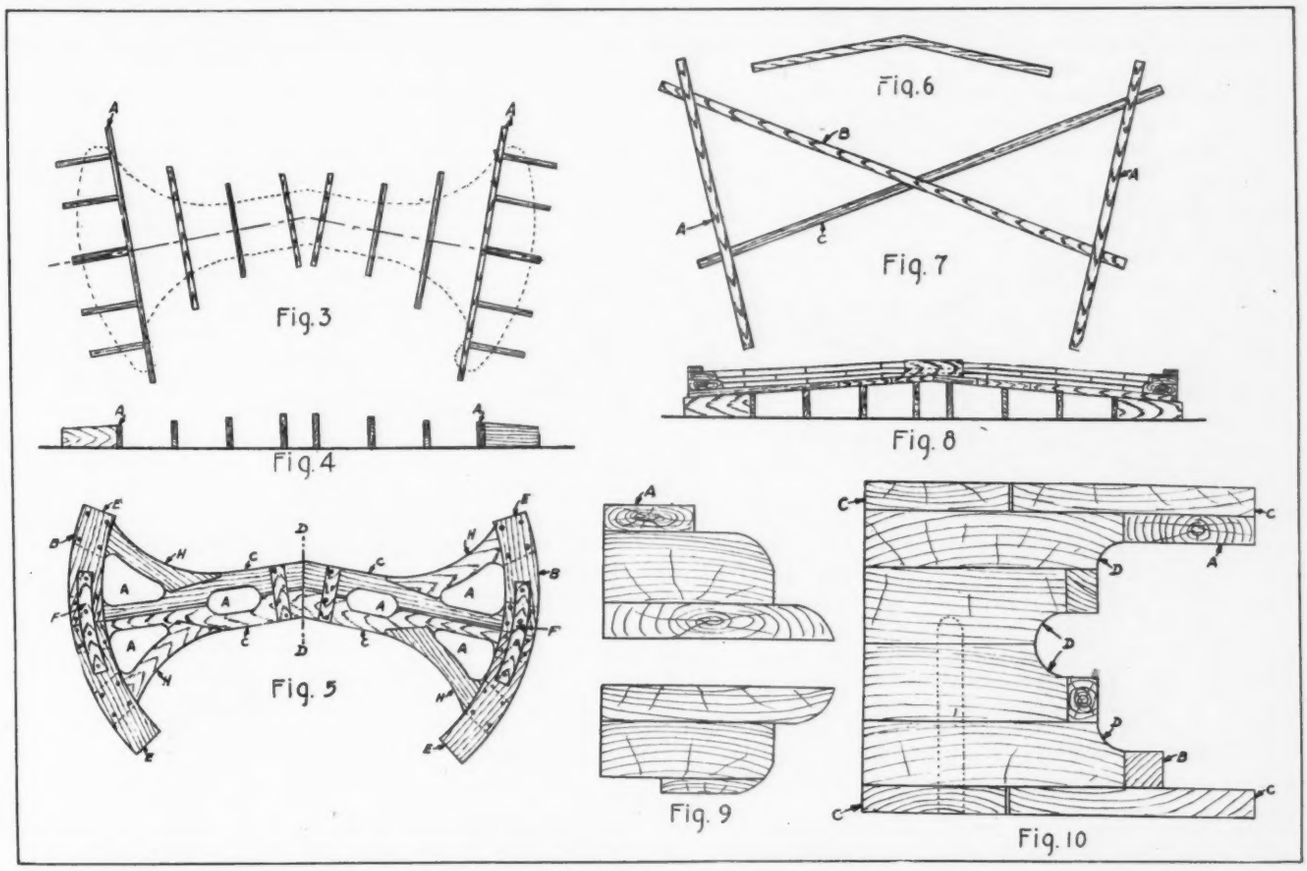


FIGS. 1 AND 2—PLAN AND SECTIONAL VIEWS OF THE RUDDER YOKE CASTING

by the molding loft for rudder yokes. Even the details can be filled-in by the drawing office. If it were not for their size they would be comparatively simple jobs, but it has to be remembered that they are sometimes 24 feet in diameter and are made of thin metal. As in the case of the rudder, a plan of the yoke and a side elevation should first be drawn on the floor with the necessary contraction allowances added. Before the pattern is started a platform has to be laid down as shown in Figs. 3 and 4. It is constructed of 1½ or 2-inch timber fastened by pocket screws or buttons to the floor. In the sketches they are shown at right angles to the center line, but they could be placed parallel with the center line. As the center plates will be made parallel with the center line, a better bearing is made if the center boards are set across the center line. To support the ends of the work, short pieces should be placed at right angles to the last crosspiece *A*, Figs. 3 and 4. These edge boards afford a sufficient bearing for the pattern without a covering. A covering of thin boards would not only be unnecessary, but a nuisance as it will be necessary to refer to the drawing and take sizes from it as the work is being built. If care has been exercised in transferring the widths of the edge boards comprising the platform, it should not be necessary to plan them although it may be advisable to test them with a straightedge or rather, with two straightedges, one being placed across the outer rim and the other toward the boss. This will indicate whether the platform is out of wind.

With the platform finished, the pattern may be started, the first operation being to make the center plate. It is shown in Fig. 5. It is tapered in thickness from the center outward, as will be noted by reference to Fig. 2. The thickness usually is 1 or 1¼ inch at the boss to ¾ to 1 inch at the rim. All the timber should be machine-planed to 1 inch. It is better to make the plate the shape of the finished casting rather than to core out the holes, *A*, Fig. 5. To put on prints and make a core box simplifies the patternmaking, but renders the molding more difficult if the mold is not going to be turned over, as these holes can be used for ramming. If the holes are going to be cored-out, the plate is made of boards placed edge to edge with hardwood battens inset to prevent them from warping. A plate with the holes cut through is more difficult. If the segments *BB*, were thicker, they could be built in two or three laminae, but this is not advisable because of their thin section. The center plate will have to be made in two parts because of the fall outwards. The middle pieces, *C*, should be drawn off first. They can be cut to the exact shape before they are laid down. A hardwood bar may be inset at the center end; the outer end will be well held by the segmental pieces, *FF*. Checks are cut out of the center plates to receive the ends of the pieces.

After the middle pieces have been shaped, the taper in the length can be planed off on the surface planing machine. If this is done much time and timber will be saved by jack-planing afterwards. The segmental ends, *E*, will have to be made in two lengths, because of the impossibility of getting timber sufficiently wide. These segments are half-lapped to the middle pieces and also to the pieces *H*. It is not necessary to half-lap the pieces *H*, to the middle pieces, as two screws will hold them well enough until the rims are built. The segments will suffice to



FIGS. 3 AND 4—PLAN AND SECTIONAL VIEWS OF THE PLATFORM ON WHICH THE PATTERN IS BUILT; FIG. 5 IS THE PLAN OF THE CENTER PLATE; THE STRIP OF WOOD USED TO BIND THE CENTER CORE AND SIDE RIBS IS SHOWN IN FIG. 6, AND FIG. 7 IS THE TIMBER STRUCTURE FOR SUPPORTING THE PATTERN WHILE TURNING OVER; FIG. 8 SHOWS HOW THE SEGMENTS ARE JOINED; FIG. 9 SHOWS THE GROOVE BLOCKS AND FIG. 10 IS A SECTIONAL VIEW OF THE CHAIN GROOVE CORE BOX

hold the two segments which hold the ends and the middle plates until the chain groove has been built. Screws are not a good means of securing the half-laps and lead rivets or wooden pegs should be used, the method of making and inserting them having already been described in the previous article on rudders. Although much of the planing could be done as each piece is made, the whole surface will have to be gone over with the try plane. In the yoke under consideration the center boss and the side ribs are not wide enough to hold the plates firmly and an additional means of binding the plates has to be found. A good way is to shape a piece of hardwood like Fig. 6, and glue and screw this to the plates. This need be only 1 inch thick, but a similarly shaped piece, but wider, can be half-lapped in the middle of the plates.

The plates being finished, the next task either is to build the ribs *A*, Fig. 12, or the chain groove blocks *BB*. Probably one man would get the groove blocks ready, but in any case it is better to build the ribs first. They can then be finished off and the blocks fitted against them. The timber should be planed about ¾ inch thick for the segments. It is advisable, in building the segments of the ribs, to finish off the inside and to leave the outside full size to be cleaned off with gouge and spokeshave or circle plane afterwards. Taper should be left on the inside. No joints must be made across the center of the ribs as they are being relied upon to hold the two plates.

Fig. 8 shows the joints of the segments. The center segments of the first two courses must be carefully bedded down. The ribs at one side of the plate will be shorter than the other side, because of the grooved block at the back of the rib. It is much easier to cut the block when it is of the same section from end to end, and it is better to build the terminal ends as part of the ribs than to make them separately. This is shown clearly at *BB*, Fig. 12. The center boss, if it is very large, should be built with segments, but a solid timber boss is useful for binding the plates. A circular facing can be screwed on to complete the boss. Before the work is lifted from the platform it will be well to finish the ends of the ribs and screw the groove block in position. The ends, *BB*, will have to be cut down to the print thickness.

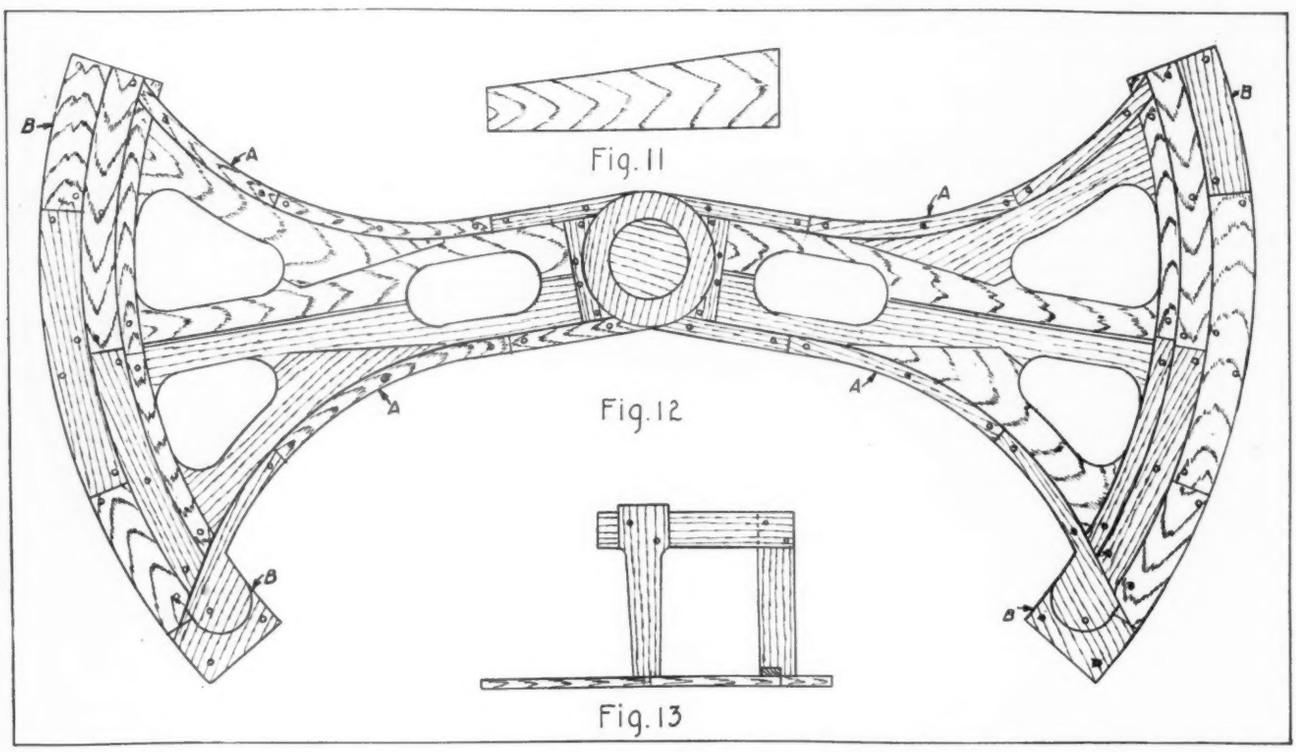


FIG. 11—A TIMBER DETAIL; FIG. 12 IS THE PATTERN SHOWING THE RIBS AND CHAIN GROOVE BLOCKS AND FIG. 13 IS THE DEVICE FOR MAKING THE MIDDLE CORE

Thin Metal in Groove Block

In making the groove blocks which have to be segmentally-built, more care is necessary if they have to be finished by hand than by machine. Fig. 9 is a section of the blocks for either side. These blocks, of course, must be cored out. These usually are very thin metal, ⅜ or ½ inch thick. It will be observed that the print is carried above the plate on the top block in the sketch, while in the bottom block it is a continuation of the inside of the metal. This is better decided by arrangement with the foundry. If the face at *A* is molded down, the print is a good guide when setting the core and if it is in the top side of the mold it acts as a check. It is too shallow to be dangerous in lowering the cope. If there has been no opportunity for the patternmaker to consult with the molder owing to the foundry being at some distance from the pattern shop, it is better not to make a check print, but to carry it out in line with the inside of the metal, both for top and bottom. The groove blocks ought to be built on a level board and it is well to make the segments of suitable thicknesses so that there will be as little hard tool work as possible.

Each segment may be squared inside and outside and the corners rounded off with the template before it is screwed and glued down. As the center plate is tapered, it is necessary to plate the bottom of the blocks so that the plates will be square. After they are built, they can be turned upside down and two angle templates attached to the building board at either end of the blocks and a straightedge will guide the craftsman in planing-off. This is one of the cases where it is quicker and more practical not to geometrically project points. If, however, instead of $\frac{1}{16}$ inch or thereabouts, the taper were ½ inch it would be wiser to

geometrically draw a line on the inner side of the blocks and with care, much of the planing could be done by machine.

The work must now be prepared for turning over, a process which has to be carefully done. Fig. 7 illustrates the necessary structure which may be made from timber, about 2 inches thick. This should not be removed until the pattern is in the sand. The pieces, *AA*, are a sufficient width for their tops to lie level with the center bogs, but the cross-pieces *B* and *C* should be 7 or 8 inches wide and checked at the center. They may be fastened by means of long screws. The screws through the center plate may now be taken out and the whole job turned over on the level floor. The platform can now be taken up, and the timber returned to the wood storage.

Before the patternmaker undertakes further work, the outside of the ribs should be finished. A square can be used from the plate and when the ribs are built on the other side, a straightedge may be used in finishing them. It is much easier and more accurate to do this than to build both sides and then finish, as there is no good guide. It is not necessary to explain the work of building the other side as it is similar to what has already been done. It probably will be necessary, when the whole pattern is completed to finally touch it up. It may be mentioned here that as rudder yokes are inclined at an angle fore and aft, the center boss, when a yoke is lying on a level floor, should not be square. It is much better for molding, however, to make the boss square and the inclination is so little in the width at the boss, that the discrepancy caused by making the boss square may be rectified by leaving more machining in the center core and by increasing the diameter of this core. The boss will be bored in the machine shop at the correct angle. Prints, about 1 inch thick, will have to be screwed on the boss. They need not be thick as they are simply a guide and not a support for the core.

A skeleton box may be made for the middle core, although steel foundries do not like skeleton work. A simple way of making the core is by means of a plate and pinboard, Fig. 13. The plate may be made of 1-inch timber, the spindle being turned 2 to 2½ inches in diameter at the top and the board proper should be about 1 inch thick. The pattern shop usually relies upon the foundry to have a core box in stock suitable for this center core.

The chain groove core box is a more difficult job than the boss core box. If a check print has been made, either two core boxes will have to be made, or if one core box is provided, it will have to be so constructed that it can be altered to make it suitable for both ends. The core at the terminal end changes in shape, as shown in Fig. 1. The slot is just sufficiently wide to allow the chain link to slip into it and the end of the second link rests against the semicircular end of the groove. Before beginning the construction of the box the method of alteration has to be decided. There are two ways by which this can be done. In the section of the core box Fig. 10, the segments *A* and *B* are made the same radius on the inside and if the taper of the metal were the same on the top and bottom, it would be possible to reverse the box by changing the segments. But as the taper is different, this method cannot be adopted. It is necessary to change the slot from one end of the box to the other. The box angle may be made the same length and section throughout, or the groove section may be cut short an equal distance from each end and blocks made which can be interchanged.

A still better way of altering this box is to make blocks only for the terminal end and to leave enough space between the end of the groove and the end of the box so that the blocks can be changed over. If this is done a false end can be screwed into the box against the chain groove. The bottoms are made of open-jointed plates battened on the back, *CC*, Fig. 10. The battens are not shown on the sketch to avoid confusion. If the core box is made in a shop where there is a patternmaking machine the segments can be built rough, but if not, great care must be taken in building. One-half could be built first and the other built on top of it, but it is quicker, and with ordinary care as accurate, to build both halves at once and finally dowel them together. It is easier to cut the fillets *D*, Fig 10, if they are an exact quarter so that it is advisable to make the straight continuation of the radii as separate segments. Each course of segments will be crossed as for ordinary segmental work. It is a matter of choice whether the fillets are cut before the segments are laid or altogether. All the fillets can be touched up with the outside gouge when the box is built and then sandpapered. The cutting of the alteration blocks does not require explaining. If both halves of the box have been accurately made and the blocks also are accurate they will fit well into both ends of the box.

Methods for Reducing Casting Losses

By E E Leib

SINCE he first started to work in the foundry, the writer has witnessed many changes. Improved processes have been adopted and machinery has been installed, while time-honored rule-of-thumb methods have been discredited and discarded; however, we are a long way from a desirable state of efficiency. Our scrap heaps are too large, or in other words, too many castings are *lost*. When casting losses do occur, the intelligent foreman or molder soon should be able to locate the causes providing he first eliminates the luck fetich entirely from his mind.

Recently, a large brass foundry secured a contract for a large number of pipe flanges to be used in government shipbuilding. These castings varied in weight from two to 80 pounds and were cast from bearing metal. Much so-called bad luck was experienced. For six weeks, four experienced molders worked on the job and did not produce as many good castings as should have been expected from one molder. Even the castings accepted as passable were imperfect. Every known method and experiment was used, and manager, foreman, molders and furnacemen were in despair of finding the remedy. When the metal was hot, a few good castings were produced, but if the metal was dull, all the castings poured were scrap. The main trouble was that the castings had a rough, wrinkled, seamy appearance, known in brass shop parlance as *smoky*. As the result of an experiment a system of gates and risers had been developed that theoretically was sound.

A new molder was employed and the foreman gave him a flange pattern to work. The pattern was about 9 inches in diameter, was made in a 12 x 16-inch iron flask, and about 20 pounds of metal was required to

fill the mold. When the new molder gated his first mold, he was instructed by one of the other flange molders. In one end of the flask, a down-gate or sprue pin was placed and at the joint of the mold three openings were cut into the main mold cavity. A large riser was placed in the opposite end of the flask and in each corner.

Before pouring his own molds, the new molder watched some flanges poured on other floors, and noted that the molds were poured too slowly. After he had made five molds, the metal was brought to his floor. Three molds were placed flat on the floor and the molder poured them fast. The metal practically was thrown into the gate. He only required about one-sixth the amount of time to fill a mold as did the flange molders working on similar sizes.

The foreman was handling the skimmer, and when the molder was preparing to cast the fourth mold, the foreman remonstrated:

"Here, you can't run them that way!"

The foreman's exclamation was caused by the fact that the fourth and fifth molds were placed on the floor at an incline of about 20 degrees, and the pouring gate was placed at the lower end so that the metal had to run up hill.

"Let me pour these my way," said the molder, "and if the castings are not good it's my fault."

The foreman shook his head at the helpers in a pitying manner, but he gave the molder his way. These last two molds were poured as fast as the others.

Tilting Solves the Problem

When the molds were shaken-out, the three flanges poured fast, and those placed in the molds on a level were passable, while the two poured up-hill were perfect and were acknowledged to be the best made from that particular pattern. After that all the molds were tilted with the gate at the lower end and were poured fast.

On the next molds made on this job, the elaborate system of gates and risers was discarded. Only one opening was cut into the mold and a good riser was placed directly opposite. By tilting the mold in the manner described, the riser was brought to the highest part of the mold and, therefore, could feed the casting better. One great advantage in pouring in the manner described, lay in the fact that no difficulty was experienced in keeping the gate choked. Authorities on brass foundry practice place great stress on keeping gates choked to prevent air from entering the gate. When the molds are tilted the gate remains choked even if pouring is irregular or ceases entirely. Furthermore, smoke has no chance to remain in the mold, as it is driven out of the riser before the advancing metal. Also, fast pouring reduces to a minimum the formation of oxides on the surface of the metal inside of the mold. Any foundry worker has noted how oxides form on the quiet surface of a ladle of molten metal. This is avoided if the metal is poured fast and in a tilted mold.

The molders who worked on the flange job were afraid to practice fast pouring for fear of run-outs. The flange molds exposed a large lifting surface against the cope, and it was customary to pile several weights on each mold and even then run-outs occurred. The critical time for a run-out to start is at the instant the mold is full and the whole cope is at once exposed to the lifting action of the metal. With the up-hill method of pouring the flanges described, there was no critical moment, the level surface was reduced and one ordinary snap weight was sufficient to hold down the cope.

No Trouble from Dull Metal

Much of the trouble which was termed *smokiness* and *bum metal* was in reality cold-shut. Up-hill pouring cures that trouble even if the metal occasionally is dull. It is the writer's theory that when pouring starts, the first metal through the gate spreads out unhampered in the wide spaces of the mold. Some of this finally stops because of friction with the sand, and some because the cold surface of the mold chills the metal, thereby rendering it sluggish. Irregularities in pouring and various other agencies cause this first metal to remain alone for a time, and when finally other metal arrives, it is chilled and often a cold-shut or mis-run casting results. While the delay may be almost infinitesimal it may be enough, especially in light work, to cause serious results.

For many pieces of ornamental work, and for castings with exceptionally smooth surfaces, the up-hill method of pouring will aid materially, as metal cannot have a cutting or washing action on the face of the mold. In making matches, follow-boards and match-plates, the patterns often can be so arranged that this method of pouring can be used by simply tilting the pattern.

Several years ago the writer secured work as a molder in a shop making warm air furnaces. Practically all castings made in furnace shops are large, thin pieces, light in weight, and they require careful pouring with hot metal. On practically all of this work, nearly all of the mold is in the cope, with nothing whatever below the parting line in the mold. The usual furnace shop practice is to gate these pieces on top by means of flat or wedge gates. In this shop no wedge gates were used, everything was gated from the bottom or the joint and the molds were poured with from three to six hand ladles.

Runouts Cause Trouble

This method of gating greatly increased the molders' work. Much larger flasks were necessary to accommodate the gates, much labor was required to finish the molds, and run-outs were frequent. The extra labor and expense did not end in the molding room. So many gates at the joint increased the lifting surface enormously, and the result was finning and overweight castings. This added much grinding and chipping. Although uniform success was attained in running the work, and seldom was a casting mis-run or cold-shut, the finishing cost was excessive under the system of molding employed.

Finally a new superintendent took charge of the foundry, and he engaged a rigger experienced in handling stove and furnace work. Smaller flasks were made and flat or wedge gates were used on top of the molds. These changes, however, did not overcome the difficulties. Castings that were not misrun or badly cold-shut were rare. The superintendent then hired a molder described as a *flat gate expert*. But the expert had no better success than the other molders. After much costly experimenting, both the superintendent and the rigger were discharged and the shop resumed its former methods.

What was the reason that this shop could not succeed with the same methods employed in other shops? All the conditions were the same, or practically so, with one exception, dull metal. The superintendent believed implicitly in a low melting ratio, and in this he was eminently successful. His melting ratio would have been a credit to a shop casting the most massive castings.

By reason of specializing exclusively in babbitt-lined, bronze-backed bearings and bronze bushings the name of the Federal Brass Works, Detroit, has been changed to the Federal Bearing & Bushing Corp. Lloyd P. Jones is president of the company.

Bill Fishes, and Talks Brass Founding

Fisherman's Luck is the Portion of the Customer Served From the Miscellaneous Brass Scrap Box at Bill's Foundry

By Pat Dwyer

THE other night Bill phoned and proposed that we go fishing. He said he knew a fellow who would loan him his motor boat and we could go down the harbor and catch a mess of codfish. Now if there is one article of food I dislike, it is boiled, salt codfish and I told Bill so promptly and emphatically.

"You poor simp," says he, "you haven't got to eat them. Perhaps we won't catch any, and if we do catch some they won't be boiled and they won't be salt. And besides you can give them to me, I'll eat them, salt or fresh; boiled, baked, fried or roasted. Anyway, that is only a secondary consideration on a fishing trip. Your true fisherman does not worry whether he catches any fish or not. The fun of the trip is all he wants. If he gets any fish, well and good. He can keep them, or give them away; or sell them or throw them overboard; it really does not make much difference. On the other hand, if he does not get any, well, he has had a long care-free afternoon, a life on the ocean wave and a home on the rolling deep, you know, and all that kind of thing."

I told him he might just as well can that poetry stuff. I had made one trip across the western ocean, when coming to this land of the free, and the home of the brave, and I could assure him that this *home on the rolling deep* was no place for a man who was not a natural born roller.

"Oh! well," said Bill, "we are not going to cross the western ocean this time. You get a cod line and some hooks. I'll get the clams for bait and be waiting for you at the government wharf at 2 o'clock." Then, as an afterthought, he added, "You had better wear a slicker and a pair of rubber boots. These here codfish are right wet when you pull them out of the water."

I was on hand at 2 o'clock and climbed aboard the SEA-MEW. We lit our pipes. Bill started the engine and we were off. I asked him where the fishing grounds were and he said: "Well, it all depends. We could go outside the Light, which is about 10 miles, and catch big fellows, 3 or 4 feet long; or we can go down the harbor about 5 miles, to a place I know, and catch little fellows about 1½ feet long."

Bill Insists on a Discussion

"Speaking from bitter experience," I said, "the chances are that if we go outside the Light the engine will die on us and it is a long paddle home in the dark, with the probability of some big ore boat running us down. I'm in favor of this 5-mile place where the little, short fellows live."

"All right," said Bill, "they all taste alike when they are cooked. Fishing is a good deal like the foundry business. There are different ways of making a job and there are different ways of mixing the metal, but as long as the casting pleases the customer what's the difference how it is made?"

"I did not come out here to answer questions," I said, "work the problem out for yourself."

"Well, now, I am not discussing this thing from a technical standpoint. That is a phase of the question which is all right in its place, and a technical knowledge of a subject is a handy thing to have for settling arguments, if nothing else. But confidentially speaking, as between man and beast, there is a lot of brass melted, good brass, too, by men who would be surprised if you told them that brass and bronze were not synonymous terms. Now, if the men who make the brass don't know what's what, how can you expect the customer to know? The general impression seems to be that any metal that is melted in a foundry and looks yellow, is brass.

"I remember the first experience I had in making this pay-your-money and take-your-choice mixture. I had been working in a foundry which was part of the repair department of a big iron and steel plant. All the castings had to conform to certain specifications and analysis. Naturally, in order to get results, we had to use a great deal of new metal. In fact, the only scrap used was remelt, return from the machine shop and scrap castings. After a few years' experience I could tell you off-hand, or with one hand behind my back, or faith, with both hands in my pockets for that matter, the proportions to use, the anticipatory analysis and the class of work requiring any of 15 different alloys. We poured a couple of tons every day and it was only natural that I thought that I knew all about brass castings. That just goes to show how young I was.

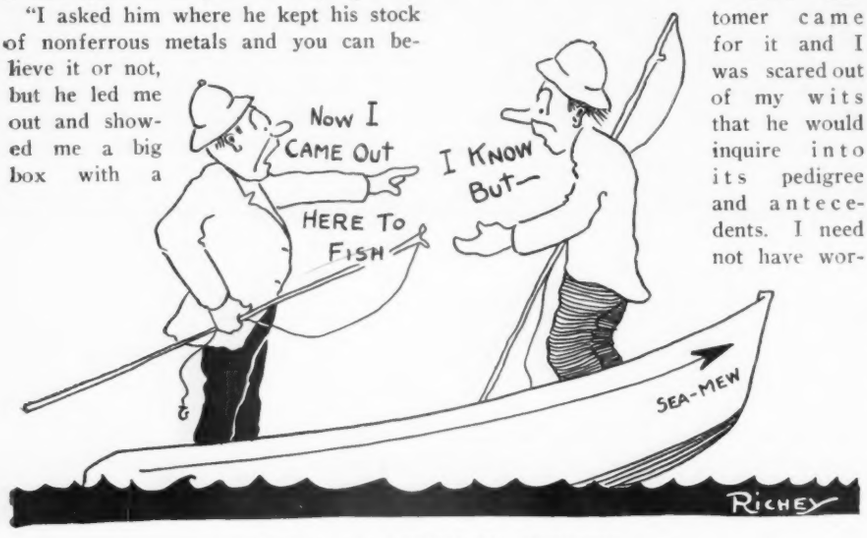
"The very next job I got I realized that I was only an amateur. This was a small jobbing iron foundry where they averaged a couple of pots of brass a week. The first job I had was a little propeller about 2 feet in diameter. The manager told me about it and said, 'I suppose you know of some

good mixtures for those kind of things.'

"Yes," I said, "fashions change from year to year, but this summer it is considered the proper thing in the best circles to pour them with monel metal or manganese bronze."

" 'Oh, yes,' said he, 'just so. Well, I will leave it to your own judgment.'

"I asked him where he kept his stock of nonferrous metals and you can believe it or not, but he led me out and showed me a big box with a padlock on it, strong enough for a safe in the Bank of England. He went into the office, got the key and unlocked it. I naturally expected to see a neat, if modest, pile of copper, zinc, tin and lead pigs, some phosphor tin and a fair sprinkling of the other ingredients, which are sometimes used in seasoning the brew in a brass pot. As I remarked before, you can believe it or not, but the box was simply filled with junk. You know the kind the junk man gathers up—plumbers' fittings, old chandeliers, several bundles of these tongs that you find in boxes of chocolates, coils of telephone wire 40 miles to the pound, brass locks, door knobs, old candlesticks, tops of lamps, tin tags and tobacco signs. There were a few pieces of good scrap and a few pieces of copper pipe.



FISHING AND FOUNDING NOT COMPATIBLE

" 'Quite a collection,' I remarked politely.

" 'Oh! yes,' said he, 'there is quite a variety. You will find a couple of kegs of turnings in the machine shop. You should have no trouble in making up most any kind of a mixture with that variety to choose from.'

" 'I guess,' said I, 'mixture is the word.'

" 'When you get enough,' said he, 'be sure to lock the box and put the key back in the office.'

"Then he sailed away and left me figuring how to make monel metal. After considering the proposition for a while, I decided that, since he was the boss and paid the bills, and also gathered in the shekels, then if he could get by why should I worry? Well, anyway, I filled the pot with borings. When that settled down I filled it with scrap, and kept on adding scrap, including a few pieces of copper pipe until I had enough to pour the casting. When it was cleaned up, bored out and polished, it looked right classy.

"The customer came for it and I was scared out of my wits that he would inquire into its pedigree and antecedents. I need not have worried. The manager showed it to him and assured him it was cast from our own special propellor mixture. The customer looked wise, and said 'Just so, it certainly looks good.' And that was the last I ever heard of it.

"I remained there a few years and made a wide variety of castings for a good many different people. Not one of them ever inquired into the analysis. When ordering, some of them would specify that the casting be made of manganese bronze, phosphor bronze, gun metal, hard brass or soft brass, as the case might be. The manager would say, 'Certainly,' pass the order on to me without a smile and when the castings were made, if they were solid and clean, the customer accepted them, and thought they were getting exactly what they asked for. Generally speaking, there is a lot of ignorance about the brass business. Among the undigested stuff is—What is brass? How is it made? and what alloys are most suitable for certain purposes?

"During my term of office I made castings for British, Canadian and American engineers to conform to a half dozen different analyses, if they had been made according to Hoyle; and in order that nobody could say the mixtures were all alike, I sometimes used my right hand to select the scrap, sometimes my left hand, sometimes both hands, and sometimes a shovel. In all that time I used just two copper ingots. They went into a copper ring for some part of the machinery in a wireless station. The order distinctly specified copper. When I drew the manager's attention to it, he said: 'Oh, I guess you can get enough stuff in the box to make it.' I said, 'No, copper is copper, and there is no way of getting around it but by using copper.' He got the stuff, but he as much as intimated that he was disappointed in me, and that if I were an A1 foundryman I could have doctored up a mess out of the box to make it. I learned a lot there about making brass castings.

"You know about sleeves, linings or bushings. They are made in all lengths and diameters. Some are molded horizontally and poured on an incline and some are made upright and poured from the bottom. Now, brass is a comparatively sluggish metal and any dirt or dross is almost sure to float a certain distance and then stick to the mold or core. And the aggravating thing about it is, that it generally has only a very few fine points of contact. The metal flows all around it and the casting, when cleaned, is apparently all right. It is only when the machinist takes a cut that the dirt

CHOICE SCRAP KEPT IN A STRONG CHEST

BILL BEATS IT IN THE GLOAMING

shows and the casting is scrapped. It is one of the seven wonders of the world, where all the dirt comes from, but there is some in nearly every green sand job that is cast. Sometimes it does not show and then the molder pats himself on the back, but sometimes it does show and then somebody else pats him on the head—with a brickbat. The machinist will tell you right away that the molder who made the job was a *slob* and did not clean out his mold properly before pouring the casting. You are a molder and know different.

"I bet you have seen any number of molds properly made and perfectly clean, and still the castings would be dirty. I don't mean spongy or with gas or blow-holes in them. That is something else altogether, and is due either to oxidized metal or wet sand, but just dirt, a compound of slag, sand and metal.

"Being of an inquisitive nature, I cast some bushings in open sand, poured the metal fair, down one side of the mold. Before it was half full, a lot of scum had formed, here and there. The metal being hot and fluid, and going in fresh at the top, kept it in motion and floated it clear to the top. I had no more trouble with dirty bushings after that and besides, it only required about half the time to make them. Sometimes, if the scum showed an inclination to stick to the sides of the mold, I would just touch it with a small rod and keep it floating."

He stopped for a minute to look around and said: "I guess this is as good a place as any."

He stopped the engine and threw out the anchor. We got our lines ready, baited the hooks with clams and settled down to business. We stayed there a couple of hours and caught two dozen. I pulled up four and Bill got the rest.

Then, as the poet says, "The shades of evening were coming down fast," so we pulled up the anchor and beat it for home.

New Method For Determination of Phosphorus

ACCURACY is the prime essential in the laboratory but speed is also appreciated. Therefore, the rapid methods which are evolved from time to time are welcome to the analyst if they prove accurate. The following rapid method of estimating phosphorus in bronzes was given out in a paper read before the British Institute of Metals by T. E. Rooney, A. M. S. T.

Bronze drillings, to the amount of from 0.5 to 2 grams, are dissolved in a mixture of 20 cubic centimeters strong nitric acid and 10 cubic centimeters strong hydrochloric acid, or, if preferred, 60 cubic centimeters nitric acid (specific gravity, 1.135), and 10 cubic centimeters hydrochloric acid. The mixture is digested without boiling until most of the red fumes have been evolved. If the concentrated acids are used the mixture is then diluted to about 70 cubic centimeters. The liquid is next cooled and 40 cubic centimeters of ammonia (specific gravity, 0.96) added slowly with constant shaking, followed by 35 cubic centimeters of nitromolybdate solution, and the whole shaken well for a few minutes. The mixture is allowed to stand for one to two hours until the precipitate has settled out, when it is filtered, preferably on pulp, washed with water until free from acid. The filter and precipitate are transferred back into the flask, excess of N/20 caustic soda run in from a burette, the whole well mixed and the excess of caustic soda titrated with N/20 sulphuric acid, using phenolphthalein as an indicator.

One cubic centimeter N/20 caustic soda = 0.00337 per cent phosphorus on 2 grams.

The method is based on the well-known volumetric method of estimating phosphorus in steel. It is best carried out in a 600 cubic centimeter conical flask using a rubber stopper in the final shaking.

1. The digestion with acid must be long enough to oxidize all the phosphorus, or results will be low.
2. Boiling or heating must not be

(*Concluded on Page* 363)

Results Obtained With Different Samples of Commercial Bronze by Rapid and Gravimetric Methods of Analysis

Copper	Tin	Lead	Zinc	Iron	—Phosphorus— Gravimetric	Volumetric
88.32	2.56	8.08	0.11	0.24	0.45	0.42
88.30	2.59	8.06	0.11	0.24	0.39	0.41
88.59	10.63	....	0.06	....	0.80	0.81
88.57	10.65	0.02	0.14	....	1.43	1.40
88.92	10.00	....	0.18	....	0.76	0.74
77.31	10.30	10.45	0.10	....	1.45	1.44
88.95	2.07	8.24	0.16	....	0.44	0.42
93.73	6.07	....	....	....	0.17	0.18
89.60	2.41	7.76	....	....	0.39	0.37
88.59	10.14	....	....	....	1.24	1.22
88.58	10.37	0.06	0.88	....	0.011	0.010
78.05	8.76	12.48	0.24	....	0.43	0.44

Factors in Selecting the Proper Core Binder

Four Classes of Binders Have Different Qualities and Their Use is Dependent Upon The Sand and The Kind of Core

By Werner G Smith

CORE binders may be divided into two general classes, liquid and dry, and each of these is in turn subdivided into two further classes, moisture absorbing and nonmoisture absorbing. The moisture absorbing binders of the liquid class include molasses and similar materials, while among the nonmoisture absorbing binders of the same class are the vegetable oils such as linseed oil, corn oil, soya bean oil, china wood oil, cotton seed, lumbang and purilla oils.

Among the dry binders the moisture absorbing types include products manufactured from corn and the products of paper mills. The nonmoisture absorbing binders of this class are pitch and pitch binders, rosins and gums.

The function of a liquid core binder is to cover each individual grain of sand with a thin film after being thoroughly mixed with the sand. Capillary attraction then draws the oil to the point of contact of one grain to another and as the film of the oil is solidified it cements the grains together.

This hardened film or cement is very thin and as a consequence does not reduce to an appreciable extent the porosity of a core in which a sharp, open sand free from loam is used. Loam fills up the spaces between the grains of sand and prevents the film of the binder from being drawn entirely to the point of contact. The real binding position should be at the point of contact and not in the spaces between the grains.

Generally speaking liquid binders are used on comparatively small and intricate cores where venting of the core and removal of the burned core are difficult, and dry binders are used on larger cores where venting and removal of the used core are comparatively easy.

Because of the difficulty of venting comparatively small cores of an intricate nature, a liquid binder is generally used rather than a dry binder. Liquid binders are also usually employed for the smaller and intricate cores in preference to dry binders because they are more easily destroyed by the heat of the molten metal and thus allow the burned core to be easily cleaned from the casting.

Dry binders on the other hand are more economical providing the core is of a sufficient size to allow artificial venting. Such venting is usually necessary where a dry binder is used, because these binders form a paste which hardens between the grains, holding them together and this paste clogs up the air spaces making artificial venting necessary. In large castings where it is easy to dig out the core, the fact that the heat of the metal does not break up a core made with a dry binder as readily as one made with a wet binder is not an objection.

The moisture absorbing and nonmoisture absorbing binders of the two classes of liquid and dry binders are quite diametrically opposed to one another. A moisture absorbing binder absorbs moisture from the atmosphere or from any moist substance with which it may be in contact. This necessitates an immediate use of a core made from such a binder, otherwise the binder may absorb enough moisture from the air or by contact with molding sand to destroy the binder and weaken the core.

Nonmoisture absorbing binders being impervious to moisture retain their strength for a period of time and in fact may be used months after making.

Both binders, with the exception of pitch, are used successfully for the same classes of work. In the writer's opinion, the moisture absorbing binder is the less secure because of the care necessary to keep it from drawing moisture, for too much moisture in a core means poor cores and blows. The nonmoisture absorbing binder is usually more expensive but is safer because of the fact that it does not contract moisture.

Since both the moisture and nonmoisture absorbing binders, with the exception of pitch binders which are not destroyed by the molten metal as it sets around the core, can to some extent be used for the same classes of work, the most economical plan is to use a mixture of the two when possible.

The nonmoisture absorbing binders are frequently compounded and sold as core oils under absorbing binders of the liquid different trade names. Core oil combines many of the advantages of all the binders and has few of the disadvantages but is comparatively expensive.

The vegetable oil ordinarily used in making core oil is linseed oil. China wood, corn, soya bean, purilla and lumbang oils are also used to some extent. All these oils have about the same binding strength when properly used but have different rates of drying.

To manufacture core oil rosin or gums are dissolved in one or more of the oxidizing oils and this mixture is thinned by the addition of a light mineral oil. The purpose of thinning oils is to bring down the viscosity of the vegetable oils and gums to a good working consistency.

The viscosity of a good core oil is of extreme importance, because an oil with a heavy viscosity is hard to mix thoroughly with the sand and often results in poor cores due to irregular mixture of sand and oil. Such a mixture means that in spots of the core there is too much oil, causing blows and in other spots the core is so soft that the metal eats into it or washes the sand.

The use of an excess amount of thinning oil lessens the binding efficiency of the oil. We find this especially so among the lower-priced or so-called medium-quality core oils. There is, however, a decidedly big field for oils of this class. One principal use is in connection with moisture absorbing binders where the purpose of the oil is not only to bind the sand but to retard the other binders from drawing moisture. The second use for such an oil is with sand containing considerable loam.

Abstract of a paper read before the New England Foundrymen's association by Werner G. Smith, president, the Werner G. Smith Co., Cleveland.

Should Use a Slag Hole

By H. E. Diller

Question:—We have always had trouble with dirty iron and I would like some information in regard to our cupola. It is lined to 36 inches and has no slag hole. We melt about five tons a day.

Answer:—You will get cleaner iron if you use a slag hole placed far enough below the tuyeres so that the slag does not foam over and run into the tuyeres. The use of approximately 25 pounds of broken limestone per ton of metal, thrown in on top of each charge after the first, will also help to clean the iron by making a more fluid slag.

The Strong Steel Foundry Co., Buffalo, is now represented in western Pennsylvania, southern Ohio and West Virginia by Frank M. Erb with offices in the Second National Bank building, Pittsburgh.

Metallography Applied to Nonferrous Metals--V

The Lead Alloys and Bearing Metals Are Discussed from the Viewpoint of Their Microstructure and the Practical Application of the Latter is Defined

By Ernest J Davis

WE now pass from the alloys of aluminum to those of lead, of which the lead-tin and lead-antimony series are of considerable industrial importance. The alloys of lead and tin first will be described.

The equilibrium diagram, Fig. 1, was worked out by Dr. Rosenhain and Tucker and represents the latest work on these alloys. At one time it was believed that the lead-tin alloys formed one of the simplest series and was considered in textbooks as a typical example of binary series of the simplest type. More careful study, however, has shown that this is not so and still further research is necessary to clear up one or two controversial points. There is a considerable degree of solid solubility at the lead end of the series, lead forming with tin a series of solid solutions containing up to about 10 per cent tin. The earlier mistaken ideas about these alloys arose from the fact that when alloys near the lead end of the series are allowed to cool from fusion, even at a slow rate, both thermal arrests and eutectic structure in the alloys can be detected. This, however, is solely due to the slowness with which these alloys approach true equilibrium conditions.

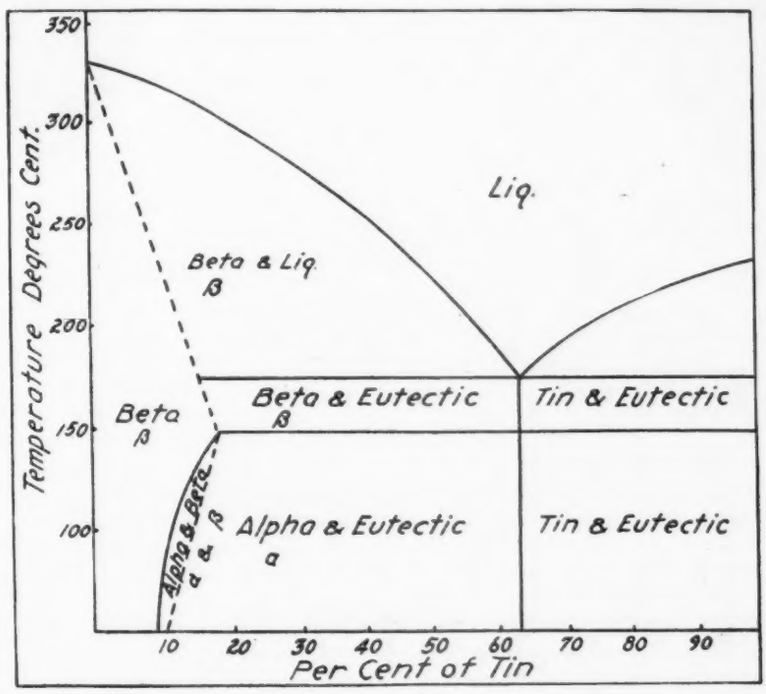


FIG. 1—EQUILIBRIUM DIAGRAM OF THE LEAD-TIN SERIES

Dr. Rosenhain found that heating as long as six weeks at a temperature of 175 degrees Cent. is necessary to bring the alloys approximately to their equilibrium condition. The simple, ideal diagram, as a result of further study, was modified in still another way. The alloys of lead and tin exhibit an evolution of heat on cooling and a corresponding absorption of heat on heating at a temperature which lies, for alloys containing from 16 to 23 per cent of tin, at 149 degrees Cent. An explanation of these arrests has been advanced by Magotto, who maintains that these arrests are due to a form of undercooling, in consequence of which the eutectic does not completely solidify at the one eutectic temperature, but remains in a metastable liquid condition until the temperature of 149 degrees Cent. is reached, when the evolution or absorption of heat denotes the return to stable conditions.

There are several vital objections to the foregoing explanation, the principal being that it is not usual for an absorption and an evolution of heat to occur at the same temperature when a metastable phase is changing to the stable phase. Degons has advanced the idea that the thermal arrests noted indicate the formation of a chemical compound. If this is the case the amount of heat evolved on cooling through the critical temperature would attain a maximum value for alloys whose composition approached that of the compound in question; a maximum does occur, but the composition of the alloys near this maximum is not consistent with any rational formula for a chemical compound, which would disprove the truth of Degon's theory.

Dr. Rosenhain and Tucker have offered the only alternative explanation, that the critical temperature in question arises from a change in the lead, which changes at that temperature in its power of dissolving tin in the solid state.

This explanation probably is correct and is embodied in the diagram, Fig. 1. As will be noted from the diagram, the liquidus consists of two branches meeting at the eutectic point which corresponds with a concentration of 37.07 per cent of lead and a temperature of 183 degrees Cent. Fig. 2 is a microphotograph of an alloy of lead and tin approximating the eutectic composition, magnified 100 diameters. The limits of the solidus at the lead end of the series are not yet accurately determined and, therefore, are shown dotted in Fig. 1. The eutectic line extends from about 16 to 100 per cent of tin and the thermal phenomenon is shown by the horizontal line at 149 degrees Cent. From the equilibrium diagram it is noted that the microstructure of the lead-tin alloys is that of a solid solution, beta, up to about 16 per cent of tin, the actual structure depending upon the method of cooling. From 16 to 63 per cent of tin we have crystals of alpha surrounded by the eutectic and from 63 to 100 per cent of tin we have primary crystals of tin surrounded by the eutectic.

The alloys of lead and tin are principally used for solders, toys, cheap jewelry and pewter. Solders are variable in composition according to the quality of the metal to be soldered. Those rich in tin, of course, are the most valuable, and the alloys are known according to the amount of

tin they contain as common, medium and best. For soldering tin and alloys rich in tin, a solder rich in tin must be employed; while for lead alloys rich in lead a solder rich in lead is used. Probably the alloy most commonly employed is that of 66 per cent of lead and 34 per cent of tin or two parts of lead to one of tin. The microstructure of such an alloy will consist of crystals of lead surrounded by a network of eutectic. Tinsmith's or tinman's solder is about the most easily fusible mixture of the two metals, that is, it approximates in composition the eutectic and its microstructure consists of nearly all eutectic.

FIG. 2—ALLOY OF LEAD AND TIN OF APPROXIMATELY THE EUTECTIC COMPOSITION

Plumbers' solder contains about 67 per cent of lead; as will be seen from the equilibrium diagram, Fig. 1, it has a range of solidification, or pasty stage, of nearly 70 degrees Cent., which allows the plumber to make his well-known wiped joint. For electrical work an alloy containing as much as 95 per cent of tin is largely used; its microstructure consists of primary crystals of tin surrounded by a network of eutectic. The best solders should be made from pure metals and not from scrap, as impurities, even in small quantities, have a pronounced influence on the quality of these alloys. Both zinc and antimony have an injurious effect on solder, although the latter is sometimes added as it improves the surface appearance of the alloy. Phosphorus, on the other hand, may be added in small quantities to effect complete deoxidation and renders the solder more fluid. The eutectic alloy itself and the alloys in its immediate vicinity solidify with an exceedingly bright surface and as a result of this, have been used for making imitation jewels, sometimes known as Fahlum brilliants for stage purposes.

Alloys rich in lead are used for making cheap toys, such as lead soldiers, etc.; these, however, contain very little tin, seldom more than 4 to 5 per cent.

The next best known lead-tin alloy is pewter. It is used extensively and its composition and, therefore, its microstructure, vary considerably. When intended for the manufacture of drinking vessels, it is essential that the alloy should be rich in tin. Those containing more than 37 per cent of lead, that is, more lead than is sufficient to form the eutectic of the series, will contain free lead in a form that is readily corrodible and is easily dissolved by acid liquids. To avoid the risk of lead poisoning pewter should contain at least 63 per cent of tin, and in France the law prohibits the use of pewter containing more than 18 per cent of lead for drinking vessels. Bearing the foregoing in mind it is evident that the microstructure of permissible pewter will be primary crystals of tin surrounded by a network of the eutectic.

The long range of solidification of some of the lead-tin alloys makes them suitable for baths used for tempering steel tools and other steel articles.

The equilibrium diagram for the lead-antimony series of alloys is one of the simplest forms, namely, a series of eutectic alloys. Fig. 3 is the equilibrium diagram for alloys of lead and antimony. A eutectic point occurs at a concentration of about 12 per cent of antimony and at a temperature of about 250 degrees Cent. The eutectic horizontal extends the whole length of the diagram and, consequently, all alloys when solid, show varying amounts of eutectic when examined under the microscope.

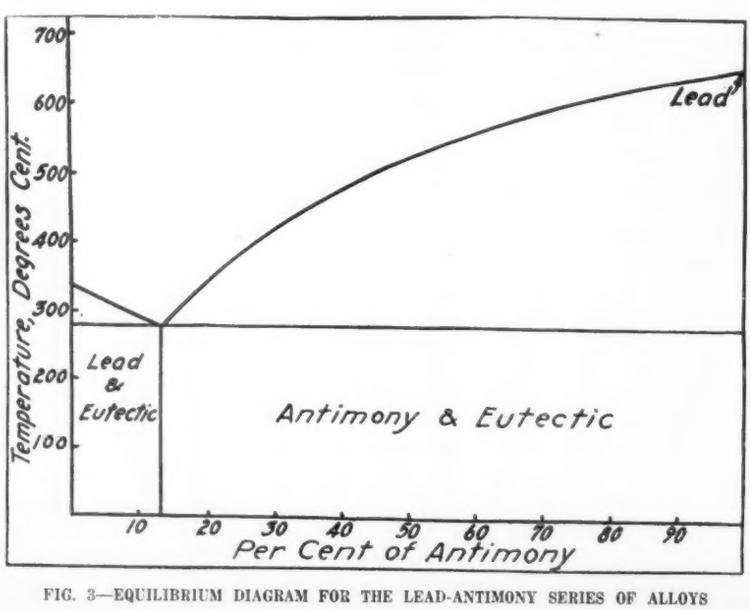


FIG. 3—EQUILIBRIUM DIAGRAM FOR THE LEAD-ANTIMONY SERIES OF ALLOYS

The alloys of lead and antimony are of considerable industrial importance. They are used in the manufacture of types, bearings, bullets, etc. With the addition of small quantities of other metals, the alloys of lead and antimony are extensively used as type metal. The essential requirements of a good type metal are (1) that it shall be sufficiently strong to withstand the necessary wear and pressure without losing its form and (2) that it shall give good, sharp castings. The second condition is fulfilled by the alloys containing not more than 15 per cent of antimony, which possesses the property of expanding on cooling; but they are not strong enough to stand hard wear. Tin is added to increase the strength, it forms with antimony a hard compound corresponding to the formula, Sn Sb, and this compound, crystallizing in the comparatively soft alloy, has the effect of considerably increasing the compressive strength of the mass without otherwise altering the character of the alloy.

FIG. 4—ALLOY OF THE TYPE METAL CLASS

The composition of type metal varies considerably. An alloy of lead, 50; tin, 25, and antimony, 25, gives good results for high class work, but is very expensive, a more usual composition being lead, 60; antimony, 30, and

tin, 10, or even less. Fig. 4 is a microphotograph of an alloy of the type-metal class.

Referring to the diagram, Fig. 3, alloys up to 12 per cent of antimony consist of crystals of lead surrounded by the eutectic, while above 12 per cent of antimony, crystals of antimony are first to crystallize and the solid alloys, containing more than 12 per cent of antimony, consist of primary crystals of antimony surrounded by eutectic. An interesting, practical application of certain alloys of the lead-antimony series has been suggested by Hannover in the production of porous metal, principally for use in the construction of electric storage batteries. For this purpose he utilizes an alloy near the eutectic composition, but to the lead side of the eutectic point. It is employed at temperatures between 250 degrees and 350 degrees Cent., that is, within the temperature range where the crystals of one metal, in this instance lead, are already solid, but the eutectic portion of the alloy is still liquid. By centrifuging the alloy at this temperature, Hannover has found it possible to drive out the fluid eutectic, thus leaving behind a porous mass of lead. Alloys of this series also are frequently used in the construction of pumps for handling corrosive liquids.

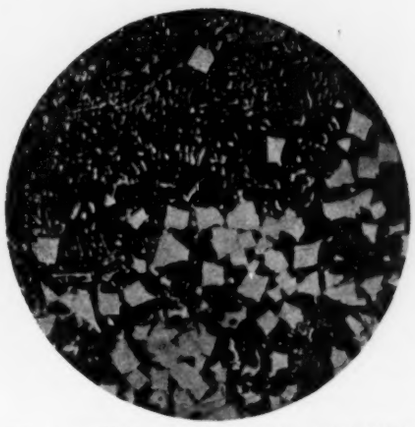


FIG. 5—WHITE METAL BADLY SEGREGATED; MAGNIFIED 100 DIAMETERS

Bearing metals embrace a number of alloys in which binary compounds occur, but although most of the alloys used for bearing metals are ternary, no ternary compounds are formed. The alloys used for bearings in all classes of machinery are of the same general type. They consist of a hard and a soft constituent, the function of the former being to resist wear and to provide a surface with a low co-efficient of friction; that of the latter is to allow of a uniform distribution of the load and to prevent local heating. If the original bearing is not a perfect fit to the journal, the soft constituent, partly by distortion and partly by rapid wear, soon adjusts itself, and forms a suitable surface for directly sustaining the load. The hollowness of the soft parts assists in promoting efficient lubrication. An excessive proportion of the soft constituent may give a metal so soft that under pressure it flows laterally out of the bearing box; on this account, an alloy is preferred, of which the soft matrix is enclosed within the meshes of a rigid skeleton framework. An excessive proportion of the hard constituent may give so rigid a structure that adjustment is prevented and heating and cutting results, while a coarse crystallization of the hard compound leads to the same result and must be avoided in bearings.

Alloys that are too soft wear the journal more than the harder alloys, on account of the gritty particles becoming embedded in the soft matrix, causing it to act in the same manner as a grinding tap. The metals entering into the composition of bearing alloys are copper, tin, antimony, lead and zinc and perhaps nickel and phosphorus; but most of the bearing alloys used are ternary alloys, that is, they contain not more than three of the foregoing metals. In an article by the author entitled "Bearing Metals," published in Vol. 9, pp. 562 to 565, *Metal Industry*, bearing alloys were divided into several classes according to the metal in excess. Thus, group 1 contains alloys rich in tin; group 2, alloys rich in lead; group 3, alloys rich in copper; group 4, alloys of copper containing free lead and group 5, special bearing alloys.

The alloys of group 1 consist of tin, antimony and copper and are largely used. Two definite chemical compounds are formed, one which has the formula, Sn Sb, which crystallizes in cubes and is exactly similar to that formed in the binary system of tin and antimony. The second compound has the formula, Cu_3 Sn, and crystallizes in hard needles frequently forming star shapes. The microstructure of alloys of group 1 consists of cubes of the compound Sn Sb along with stars of compound Cu_3 Sn, in a tin-rich matrix. The effect of casting temperature rate of cooling is very marked in most bearing alloys. Chill casting, imparting a fine structure, has been condemned; similarly, a coarse structure obtained by very slow cooling is fatal; a structure obtained by casting at a temperature just above the melting point of the alloy and into a mold heated to about 100 degrees Cent. has been found to give good service.

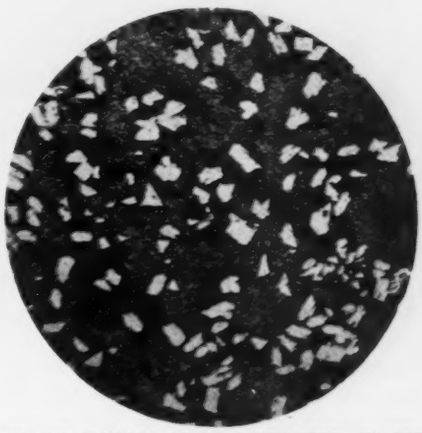


FIG. 7—BEARING METAL CONSISTING OF THE COMPOUND, Sn Sb, IN A SOLID SOLUTION OF THE COMPOUND WITH ANTIMONY; MAGNIFIED 100 DIAMETERS

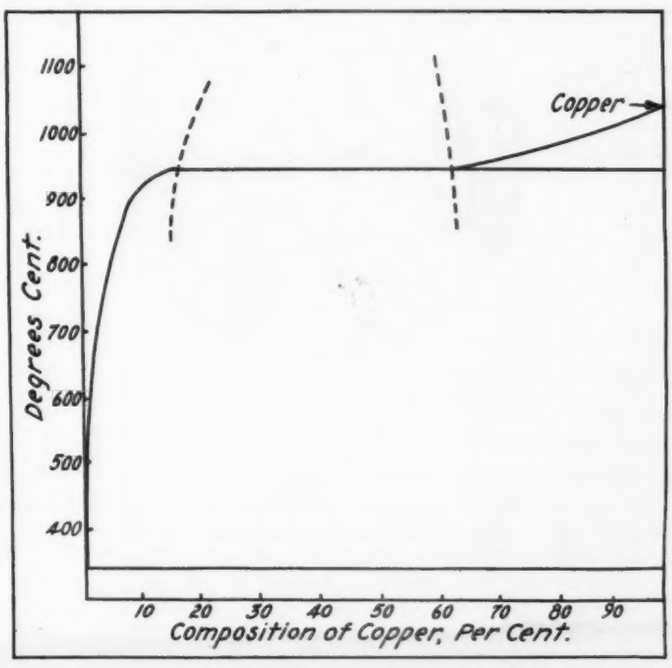


FIG. 6—EQUILIBRIUM DIAGRAM OF SERIES OF ALLOYS CONTAINING COPPER AND LEAD, TIN, NICKEL, ETC., BEING ADDED TO PREVENT LEAD SEGREGATION

It is here that the study of the microstructure is of great value and if one is familiar with the science, he

can choose readlly between a good and a bad bearing structure. In some of these bearing alloys, especially those of the next group containing excess lead, neglect to stir constantly in preparing the ingot metal may result in an extremely bad structure. The hard cubes of the compound, Sn Sb, have a lower specific gravity than the matrix and,

FIG. 8—SPECIMEN SHOWING THE SEPARATION OF A COPPER-LEAD ALLOY INTO TWO LAYERS

consequently, tend to rise to the top of the bath. Fig. 5 shows this flotation. There are other faults readily determined by the microscope and every works should be equipped with such a valuable detective.

In group 2 we have the alloys of the lead-tin-antimony series. The binary alloys of lead and antimony at first were used, but have been entirely replaced by the superior qualities of the ternary alloys. The microstructure of the ternary alloys are similar to those of the binary series, consisting of a compound of the formula, Sn Sb, embedded in a solid solution of the compound with antimony. Fig. 7 is a microphotograph of a bearing metal of this class, magnified 100 diameters.

Copper-Lead Series

The microstructure of group 3 already has been discussed in the article on the "Copper-Tin Alloys."

Group 4 consists essentially of alloys of copper and lead, tin, nickel, etc., being added merely to assist the copper to hold the requisite amount of lead without excessive segregation. The equilibrium diagram of this group is illustrated in Fig. 6, the conditions of equilibrium having been developed by Heycock and Neville, Roberts-Austen, and Friedrich and Lenoux. The series contain an eutectic point which occurs very near the lead boundary of the diagram, containing only 0.06 per cent of copper and having a freezing point of about one degree Cent. lower than that of pure lead. From pure copper to about 15 per cent copper, the diagram contains a horizontal line at the temperature of about 953 degrees Cent., almost like an eutectic horizontal, from which the liquidus curve drops sharply to the eutectic point. At this temperature, 953 degrees Cent., we have two conjugate liquid solutions containing about 15 and 60 per cent of copper, respectively; the dotted curves through these two points indicate the curves of liquid solubility, but these curves have not yet been determined with any degree of accuracy. The two solid metals are sensibly insoluble one in the other and alloys containing between 15 and 60 per cent of copper separate into two liquid layers. The upper layer at the moment when freezing commences, contains 60 per cent of copper; skeleton crystals of copper are formed in this layer at the constant temperature of 953 degrees Cent. The portion of the upper layer which remains liquid at this temperature reaches the same composition as the lower layer, namely 15 per cent of copper, and being much heavier than the copper crystals, tends to fall; but a large portion of it is held among the copper crystals and solidifies there. As soon as the temperature falls below 953 degrees Cent. the lower layer begins to solidify, together with the liquid left in the upper layer, by the separation of more copper crystals. The eutectic com-

FIG. 9—SPECIMEN OF LEAD-BEARING BRONZE, SHOWING UNIFORM DISTRIBUTION OF LEAD PARTICLES

position is finally enriched and solidification is completed at the constant temperature of 327 degrees Cent. In the upper layer, the copper crystals which separate below 953 degrees Cent. are deposited on the crystals already existing, so that the final substance to crystallize is nearly pure lead.

Fig. 8 shows the separation of a copper-lead alloy into two layers and Fig. 9 is a microphotograph of a lead-bearing bronze showing the uniform distribution of the particles of lead. In alloys containing more than 60 per cent of copper, the part which remains liquid at 953 degrees Cent., also is resolved into two liquids, but on account of the formation of an extensive, rigid framework of copper

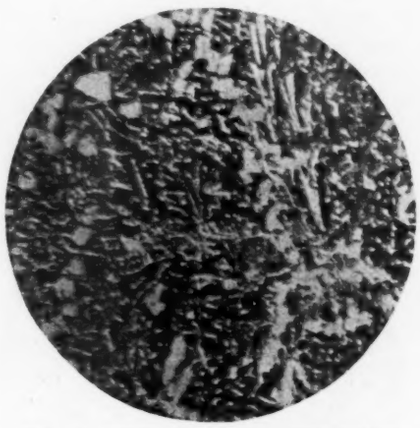


FIG. 10—SPECIMEN OF THE COPPER-LEAD-ANTIMONY SERIES

crystals above this temperature, the solid alloys show no very distinct separation into two layers.

With moderate rates of cooling the lead is distributed fairly uniformly throughout the alloy, so long as its proportion does not exceed about 15 per cent. With higher percentages, the lead begins to collect at the bottom of the ingot and with as much as 30 per cent of lead there is a poorly-defined layer of appreciable thickness. Chill castings containing as much as 30 per cent of lead are obtained fairly uniform, but those within the two-solution-region show great irregularity, even when stirred and rapidly cooled.

Tin Overcomes Segregation

The binary series, in itself, has little practical importance, but certain alloys of the ternary type are of considerable use as bearing metals. Tin usually is added to the copper-lead alloys, principally to overcome the segregation of the lead, thus insuring a uniform casting. Nickel also is used for this purpose and it has been suggested that by producing a shorter range of solidification, thus cooling the alloy quicker, segregation is more or less overcome. The alloys of this class have a wide field of usefulness as bearing bronzes and have the additional feature of being somewhat self-lubricating.

In the last group we have bearing alloys which are only used for special purposes. Examples of this series are represented by the copper-lead-

antimony alloys. These alloys essentially are lead-antimony alloys hardened by copper. The usual composition varies from 80 to 65 per cent of lead, 15 to 25 per cent of antimony and with from 5 to 10 per cent of copper.

The microstructure of this series consists of crystals of antimony and a network of purple compound, Cu_2Sb, in a complex matrix which probably would have to be melted together in the cupola, and the zinc added in a molten condition after the copper had been tapped into the ladle. This could be done without causing the metal to solidify, but there would be no means of superheating the metal after it was out of the cupola, and pouring into ingots is out of the question because of the loss of zinc in remelting the ingots. The situation would not be improved by the use of charcoal.

An illustration of how zinc is burned out of yellow brass is furnished by the methods of melting in use by the sleigh bell makers of Connecticut. It is the custom to use a small, charcoal-fired cupola for melting, and to use old scrap brass such as clock works, for the metal. The yellow brass, with its contained iron, is thrown on top of the charcoal, and as it sinks through the fuel, it is purified of its zinc, and arrives at the bottom in the form of good red brass with the iron incorporated in the slag on top. It is probable that the same result would follow the melting of manganese bronze in the cupola; therefore, if manganese bronze has to be used, it would be advisable to send the propeller out to be made.

The strength of manganese bronze should be over 60,000 pounds per square inch, and the elongation, between 20 and 30 per cent; it is ductile at a red heat, which means that if the propeller strikes a rock and a blade is bent, it can be straightened again, and the wheel is as good as ever. Under these circumstances, we doubt whether any steamship company would be justified in substituting any other alloy. The case would be similar to that of one of the water wheels in one of the Niagara Falls penstocks which, at the opening of the war, threatened Canadian difficulties on account of a drop in electric power made possible by the failure of the wheel. This wheel was cast in Cleveland, and the bronze was 88-10-2, and the other is a ternary eutectic of antimony, Cu_2Sb, and lead. Fig. 10 is a microphotograph of an alloy of this class at a magnification of 100 diameters.

HOW AND WHY IN BRASS FOUNDING

By Charles Vickers

Can a Propeller Mixture be Melted in the Cupola?

Will you kindly give us a mixture for a 6-ton bronze propeller wheel? This is a big job for a foundry that is not properly equipped to make such castings. We will have to melt the metal in the cupola. We make tail shaft sleeves weighing 1000 *pounds each, and have had excellent results with cupola melting. We usually take off a ton or more at a time, using very little blast and plenty of charcoal. Would you advise us to attempt the wheel or give it out to some one accustomed to that kind of work? What is the loss when melting brass in the cupola under the best conditions?*

The best alloy for large propellers and the one that is universally used is manganese bronze. We doubt whether this alloy can be successfully melted in the cupola. The cause of this is the high zinc content of the alloy, over 40 per cent of the mixture. The zinc could not be added to the copper while the latter was in the cupola, because a high percentage would be volatilized and the resulting alloy would be worthless. In addition to this difficulty, there would be the problem of getting the hardening elements incorporated.

Manganese bronze must be melted twice to get the best results in both tensile strength and elongation. Some of the specifications for propellers recently presented to manufacturers on the Pacific coast demanded 70,000 pounds tensile, with 27 per cent elongation, and these specifications were met by melting the alloy in oil-fired, open-flame furnaces. It was possible, in this case, to add the zinc, incorporate the hardener, complete the alloy in the furnace, and to remelt the ingots for the castings, in the same furnace; after the ingots were remelted, they were brought to and held at the proper temperature, until the required elongation was obtained. When a cupola is used as the melting medium, the copper and hardener wheels were of German manufacture and were of Ruebel bronze, a form of manganese bronze. These latter wheels gave excellent satisfaction and had been in service for many years without showing deterioration, either by corrosion or the impact of foreign bodies.

The American-made wheel, on the contrary, was corroded, had broken blades, and showed signs of general disintegration and impending disaster, and the officials of the electric power company felt themselves in a tight corner as they had no confidence in any but the German product. It was the writer's privilege to puncture this German bubble of reputation by specifying the proper formula for such castings, and the new wheel which weighed 5000 pounds, was cast in an eastern foundry, and proved to be all that was expected of it.

If, however, a red metal can be used in this case, the following alloy is the most suitable of this type, as it possesses ductility and high tensile strength when well made: Copper, 87.25 per cent; tin, 9.50 per cent; zinc, 2.50 per cent; lead, 0.50 per cent and 15 per cent phosphor copper, 0.25 per cent.

The metal should be tapped onto the phosphor copper which is placed in the bottom of the ladle, so that it will dissolve and spread throughout the mass of the metal removing the oxides, reducing them to the metallic state.

Mixture for Trolley Wheels

Will you kindly furnish us a mixture for trolley wheels for street cars that will stand hard service?

For trolley wheels the following alloy is extensively used and meets all the requirements of hard service: Copper, 92 per cent; tin 6 per cent; 5 per cent phosphor tin, 2 per cent. If a softer mixture is desired, decrease the tin, 2 per cent and increase the copper a similar amount.

Exceptional Alloy Sought

We would like to be informed just what proportion of each of the following metals should be used to form an alloy which will be noncorrosive, nonoxidizable, light and strong and inexpensive. The metals we wish to use are as follows: Aluminum, zinc and phosphor tin. We would also like to know the estimated value of the alloy per pound.

There is no metal or alloy known to scientists that will meet all the requirements mentioned. Platinum is noncorrosive and nonoxidizable, but it is heavy and expensive. Of the three metals mentioned the best to use would be pure aluminum. Simply obtain pure aluminum ingot, that is commercially pure and make the castings of that. It will fail by being subject to corrosive influences, and it will not be strong, but it will meet all other requirements fairly well. It would be advisable to mix a little copper with the aluminum, if alone it is found too weak, and about 6 per cent copper will materially strengthen the aluminum. Neither zinc or phosphor tin should be added to the aluminum, as the copper and aluminum alloy is the best. The purer aluminum is, the more resistant it is to some acids, and other corrosive substances, therefore, while it may be necessary to harden and strengthen it, this should be accomplished with the smallest possible addition of any other element. The cost of the mixture can be arrived at by adding together the cost of the copper and the cost of the aluminum in 100 pounds of alloy. Divide the result by 100 to find the cost in cents per pound.

Melting With Low Sulphur Fuel Oil

We would like to know how high the sulphur in crude oil can be before it is unfitted for use in melting and refining copper, the purity of which must be 99.98 per cent copper. The oil we are now using is guaranteed to contain under 0.5 per cent sulphur, but we are trying to obtain an oil that shall contain under 0.25 per cent sulphur.

The sulphur content of fuel oils vary with the locality from which they are obtained. Some of the Texas oils contain as high as 1.75 per cent sulphur; Ohio oils, 0.60 per cent sulphur; California oils, 0.51 per cent sulphur and high grade Pennsylvania oils, as low as 0.06 per cent sulphur. An oil containing less than 0.5 per cent sulphur, therefore, is a good grade of oil for melting purposes. It is generally conceded that the less sulphur the fuel contains, the better it is for melting copper, and if a fuel having less than 0.25 per cent sulphur can be obtained, it is advisable to use it in preference to an oil containing 0.5 per cent. The absorption of sulphur by the copper can be prevented to a considerable extent by melting under a flux of soda ash, when both sulphur and oxygen will be very low, provided there is none in the copper before it is melted; such as when a high grade cathode copper is used for the charge. Charcoal also makes a good covering for copper, as the sulphur in this fuel is very low. If coke is employed as a cover, the sulphur content of the copper will be much higher, as a good grade of coke is liable to contain over 0.5 per cent sulphur.

To obtain a copper as pure as 99.98 per cent, a cathode copper of 99.99 per cent purity should be melted under soda ash; if melted under charcoal it will be difficult to get 99.98 per cent purity, and if coke is used, the purity of the copper will be much lower.

Melting Brass for Heavy Castings

We have a number of large bushings to make which will weigh from 1200 to 1400 pounds each. The alloy to be used consists of copper, 80 per cent; tin, 10 per cent and lead, 10 per cent. We would like to be advised as to whether it is possible to melt this alloy in our cupola, without having too great a loss. Also what is a good type furnace to install for melting heats of brass of 300 or 400 pounds each?

To melt bronze successfully in a cupola, it is advisable to use considerably less blast than for iron to lessen the danger of oxidation of the metal. The melting ratio varies as it does in the case of iron. In one instance the ratio, was 5 pounds of metal to each pound of fuel, in another 7 4/10 pounds of metal to each pound of fuel. If new metal is to be made, melt the copper and when ready tap out into the ladle and add the mixture, which should be melted and be poured into the copper. The ladle should be heated well and have enough charcoal in the bottom to make a covering for the copper and the charcoal should be ignited before the copper is tapped. At least 0.5 per cent of the tin should be replaced by 5 per cent phosphor tin, so that when the mixture is added it will contain a deoxidizer. The loss will not be much greater than in the case of a brass furnace provided the copper comes down quickly.

If oil is available as a fuel, probably the best type of furnace to install would be an open flame furnace, but if oil is not available, a coke fired tilting furnace, using crucibles would be satisfactory. If electric power is cheap an electric furnace would be quite satisfactory.

Difficulties With Alloys of Copper and Lead

We have experienced considerable difficulty in making a mixture of 55 per cent lead and 45 per cent copper. We use a mixture of charcoal and plaster of paris as a flux, and add a little sulphur to amalgamate the lead with the copper. The difficulty is with blisters or sand holes that form in the metal and which are not noticed until the surface is machined. Also, vein streaks or discolorations appear occasionally which are not discovered until the metal is broken. Is it probable that the size of the gate has anything to do with this? We would also like to have you furnish us with a good pickling solution for brass and bronze castings.

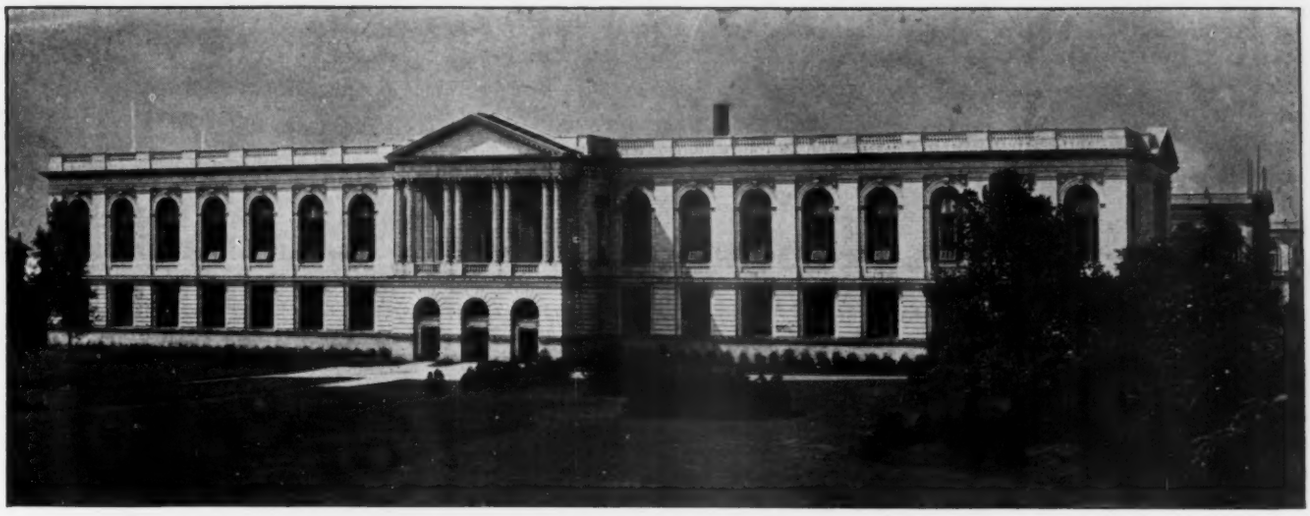
The use of too much sulphur will cause blisters and holes. Probably if the amount being used is cut in half, better results will be attained. Often hot pouring will remove this difficulty and also the copper spots. The latter can be controlled to a large extent by using heavy feeders. Have the copper spots and the normal metal analyzed and compare the results. The slag produced by the plaster of paris should be liquid and not lumpy, and this is accomplished by adding thereto, soda ash, salt and borax.

A pickling solution for brass castings consists of sulphuric acid, 1 gallon, and water, 9 gallons. Add the acid slowly to the water, stirring with a glass rod or tube. Use an earthenware crock that will not be broken by the heat developed by mixing the acid with the water. The castings must be free from grease before pickling.

What is Benedict Nickel?

We would like to obtain some information regarding the alloy known as Benedict nickel. What is its composition?

The composition of Benedict nickel may vary, but the alloy of copper 80 per cent and nickel 20 per cent is the one usually so designated. The government specifications, are copper, from 84 to 86 per cent; nickel from 14 to 16 per cent. An analysis of a sample of Benedict nickel gave copper, 79.77 per cent; nickel, 19.83 per cent; manganese, 0.06 per cent and iron, 0.34 per cent. This is practically 20 per cent nickel as the iron usually is an impurity carried with the nickel. The manganese is introduced as a deoxidizer, and it imparts good rolling properties to the alloy. Benedict nickel is not a sand-casting alloy as it is too soft and it would not run well unless aluminum were added. It usually is used for drawing into rods and tubing.



Front View of Philadelphia Museums, Where the Fourteenth Annual Exhibition of Foundry and Shop Equipment Will be Held

Philadelphia Convention Plans Taking Shape

Local Entertainment Committee Has Started Work—Numerous Technical Papers Secured—Exhibition Will Surpass Previous Efforts—Foreign Delegations Expected

PLANS for the twenty-fourth annual meeting of the American Foundrymen's association, which will be held in Philadelphia during the week of Sept. 29, are rapidly being perfected. Several delegations of British, French and other European foundrymen are expected to attend as the result of arrangements now being made in Europe by A. O. Backert, president of the association. Special stress, therefore, will be laid on both the entertainment and technical features of the program this year. Considerable progress already has been made in both directions. A local entertainment committee has been formed in Philadelphia and over 25 papers and addresses have already been secured for the professional sessions which will probably open on Tuesday, Sept. 30, concluding Friday, Oct. 3. Simultaneous sessions are being planned for Wednesday and Thursday, Oct. 1 and 2, with special sessions as usual for the discussion of gray iron, steel and malleable foundry practice. The customary exhibition of foundry and shop equipment will be held in the Commercial Museum where unusually satisfactory facilities are available, and the advance reservations for space already received indicates that the exhibition this year will be the largest ever held.

The Philadelphia local committee was formed at a recent meeting of the Philadelphia Foundrymen's association. Thomas Devlin, Thomas Devlin Mfg. Co., president of the Philadelphia association, and Howard Evans, J. W. Paxson Co., secretary, are ex-officio members of this committee. The other members include G. H. Clamer, Ajax Metal Co., Philadelphia; C. R. Spare, American Manganese Bronze Co., Holmesburg, Pa.; H. W. Brown, Tabor Mfg. Co., Philadelphia; Frank Krug, White & Bros., Inc., Philadelphia, and J. D. Hibbs, J. W. Paxon Co., Philadelphia. It is expected this committee will be considerably enlarged and its work organized through the medium of subcommittees a little later on.

Unusual historical interests are attached to the forthcoming convention, since it was at Philadelphia in 1896 that the American Foundrymen's association was organized as a result of a movement led by the Philadelphia Foundrymen's association. It is expected that the entertainment program which is being prepared for the coming convention will emphasize the prominence of the Quaker City as a foundry center. The details are still to be worked out but it now seems assured that one of the features of the program will be a shad dinner of the variety for which Philadelphia is famous. Other unique entertainment features are contemplated.

Among the technical papers for which arrangements already have been made are the following: "Results of an Investigation of Steel Castings on German Submarines," by Prof. William Campbell, Columbia university, New York; "Training Men for Foundry Work," by C. C. Schoen, training section, U. S. department of labor, Washington, D. C.; "The Comparative Qualities of Electric and Converter Steel Castings, by John Howe Hall, Taylor-Wharton Iron & Steel Co., High Bridge, N. J.; "Experiments With Melting High Sulphur Malleable Scrap," by A. W. Merrick, General Electric Co., Schenectady, N. Y.; "The Side Blow Steel Converter and Its Possibilities for the Gray Iron Foundry," by George P. Fisher, Whiting Foundry Equipment Co., Harvey, Ill.; "Micromotion Study for Foundrymen," illustrated by moving pictures, by Maj. Frank B. Gilbreth, Providence, R. I.; "Electric Furnaces for Foundry Use, Specially for Annealing Steel Castings," illustrated by motion pictures, by T. F. Baily, Electric Furnace Co., Alliance, O.; "Methods for Determining When Malleable Iron is Over or Under Annealed," by Maj. W. P. Putnam, Detroit Testing Laboratory, Detroit; "Relation Between Machining Qualities of Malleable Castings and Physical Tests," by Edwin K. Smith, Wisconsin Malleable Iron Co., Milwaukee; "How to Secure Best Results in Combining Hoisting Apparatus With Molding Machines," by W. C. Briggs, Shepard Electric Crane & Hoist Co., New York City; "Concrete Foundry Floors," by H. H. Haley, American Foundry Equipment Co., New York; "Personnel Problems of Modern Industry," by C. D. Dyer Jr., consulting engineer, Philadelphia; and "Foundry Sand-Handling Equipment," by H. L. McKinnon, the C. O. Bartlett & Snow Co., Cleveland.

Electric Steel Castings Made in Chicago Shop

A Battery of Wide-Gage Trucks is a Factor in Obtaining Top Production—Three Furnaces Are Installed and in Operation

THERE are four recognized commercial processes for making steel castings, the crucible process, the open-hearth, the converter and the electric process. Of these, the first three have been in use for a good many years; in fact the origin of the crucible process may be said to be lost in the mists of antiquity. Our ancestors who made the famous Damascus and Toledo blades did not have all the modern appliances for making crucible steel but what they did make was by the crucible process. Steel-making in commercial quantities, however, did not really commence until after the siemens-martin and bessemer processes had been brought into existence. With their modifications and improvements these two processes are responsible for nearly all the steel produced in the world today. On account of the great advances made in the application of electricity to industry during the past few years, and the possibility of obtaining high temperatures, metallurgists have naturally turned to this agent to solve some of their difficulties. The experimental stages in this process may now be said to be fairly past and the advantages of electric melting will eventually make it a strong competitor of its two formidable rivals. For making small castings, the electric furnace has many commendable features particularly in that unusually high temperatures are possible. This condition in the furnace makes an extremely fluid slag and allows the melter to manipulate the charge to a greater extent than would otherwise be possible. With a slag made up of 60 to 70 per cent sand, 15 per cent lime, 15 per cent fluorspar and 10 per cent carbon it is claimed that the sulphur and phosphorus can be reduced to 0.02 per cent or less, with suitable raw materials. The silicon and manganese additions are made in the furnace and aluminum added in the ladle to finish the oxidation.

Three Furnaces Installed

A battery of three electric furnaces is in use in the foundry of the Electric Steel Co., Chicago. As may be seen from the plan, Fig. 6, the building takes in two sides of a 300-foot square. One leg of the building is old and is now used altogether for cleaning, annealing and shipping the castings. The other leg is comparatively new and is devoted to molding, coremaking and melting. The old part of the building is fairly well lighted but the new part is exceptionally fortunate in this respect, the windows occupying nearly all the wall space. At the lower end of the building are the furnaces which are three in number. Two of them were furnished by the Industrial Electric Furnace Co., Chicago, builder of the Snyder-type furnaces. They have a capacity of 1½ and 3 tons respectively. They use single electrodes. Fig. 2 is a good illustration of their general appearance. The third furnace was made by the Pittsburgh Furnace Co., Pittsburgh, and has a rated capacity of 5 tons.

Immediately back of the furnaces is the building housing the transformers and the laboratory. The latter, which is on the upper floor, is completely equipped. It is a recognized fact that the production of electric steel castings requires considerable attention on the part of the chemist.

In a general way, the shop is divided into three sections longitudinally, the columns supporting the crane runway serving as dividing lines. On the left in Fig. 1 are a row of benches

FIG. 1—THE MOLDS ARE LOADED ON LARGE TRUCKS WHICH ARE PUSHED INTO POSITION FOR POURING AND THEN TAKEN AWAY TO MAKE ROOM FOR OTHERS

FIG. 2—TWO SNYDER ELECTRIC FURNACES IN MELTING POSITION TESE FURNACES HAVE A MELTING CAPACITY OF 1½ AND 3 TONS RESPECTIVELY. FIG. 3—SMALL SNYDER FURNACE IN POURING POSITION

and molding machines some of nearly every make being represented. With the exception of two, they are all of the jolt-squeezer type and include six Mumford, four Tabor, four Federal, six Osborn and four International machines. Two of the Osborn machines are of the plain squeezer type.

As a general rule the molders' benches and machines are located near the wall and the molds are placed on the floor beginning at the gangway. In this shop, however, the benches are placed near the gangway and the first molds are put down next to the wall. The facing sand is taken from the mixer and delivered to the different benches by an electric truck. It is found more convenient to dump the sand near the gangway than to steer the truck through a floor of molds in order to reach benches at the back.

When Pouring Cups are Used

All of the work in this shop is made in green sand. The practice does not differ materially from ordinary gray-iron work found in most shops. Pouring cups are used only on molds which are to be poured with the crane ladle. The steel is taken away from the furnace in a crane ladle which is then placed on a pouring stand. The molders form a line with their double shank ladles. A man attending the big ladle takes care of each molder in turn and they take the metal and pour their work in the same manner as their cousins in the iron shops.

The small furnace melts a heat in a little over an hour, the next size takes about an hour and a half, and

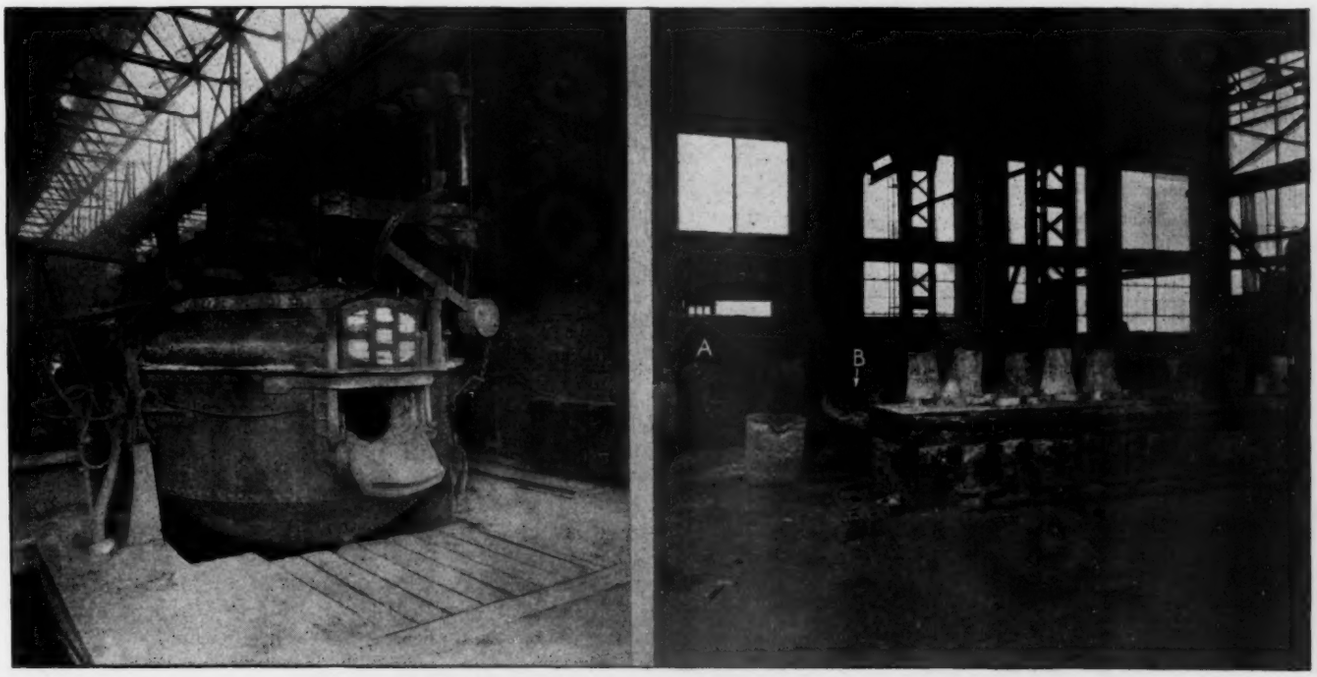


FIG. 4—PITTSBURGH 5-TON ELECTRIC FURNACE—THESE FURNACES MAY BE CHARGED EITHER FROM THE TOP OR FROM BOTH SIDES FIG 5—LADLE DRYING STAND—THE SMALL LADLES ARE DRIED OVER A ROW OF OPEN GAS BURNERS—THE LARGE LADLES ARE PLACED IN FRONT OF BURNERS LOCATED BEHIND THE WALL SHOWN IN THE BACKGROUND

the large furnace requires about two hours. Forty tons of steel is the average daily melt. The work is all light, the average weight of castings being only 20 pounds so that in some cases the gates are actually heavier than the castings. Under these circumstances 50 per cent of clean castings is considered a fair yield.

The furnaces and the stoves for drying the ladles are situated at one end of the main bay with two sand-mixing machines at the other. Both are of the revolving pan and roller type built by the Standard Sand & Machine Co., Cleveland. The floor between is devoted to molding and is divided into several units. Fig. 1 shows one of these units, the distinctive feature of which is the carriage for taking the molds away from

terns which may be required. In this instance a tractor wheel is being made. The drags are made on the machine shown at the right, and the copes on the one at the left. The trucks for carrying the molds are simple in construction and light. They are made up of two pieces of light 6-inch channel irons 15 feet long with a piece of the same material 3 feet long riveted across underneath and another piece in the middle to act as a stiffener. Long bolts as may be clearly seen at *A*, Fig. 1, join the pieces together at intervals of 2 feet. Two journal bearings are bolted to the lower side of each of the cross pieces. Each truck is carried on four 10-inch wheels and has a capacity of five molds.

The track on which these trucks oper-

by the crane to one end of the shop where the sand mixing mills are located. Here everything is dumped in one pile. The castings are pulled out with hooks and the flasks piled up and returned to the machines. The empty trucks are also picked up by the crane and returned to the other end of the track, thus completing the cycle of operations. With this method it is claimed a comparatively small number of flasks will suffice to keep the fastest type of machine working to capacity. The main bay is served by two Pawling & Harnischfeger 10-ton cranes.

The third section of this building is taken up by the transformer house and laboratory. They are partitioned off from the rest of the shop. The electrical installation is on the ground floor immediately back of the furnaces while

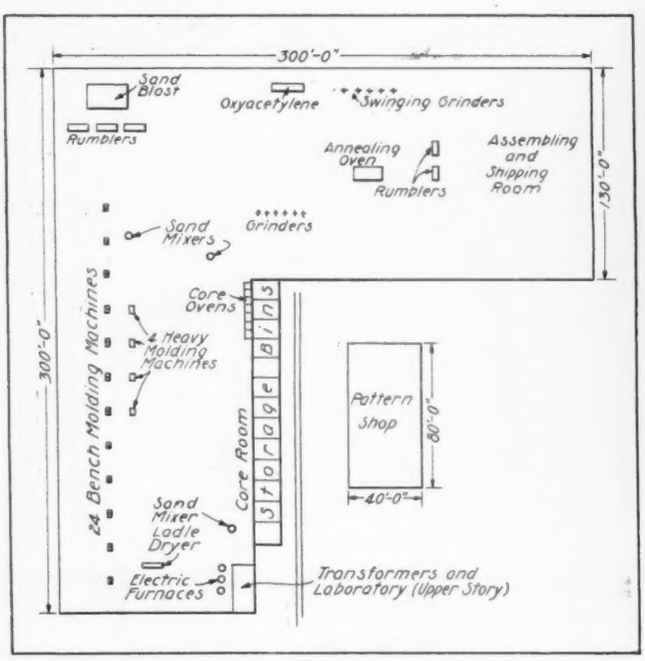


FIG. 6—GENERAL PLAN OF THE FOUNDRY SHOWING LOCATION OF MOLDING MACHINES AND FURNACES

FIG. 7—CAR TYPE ANNEALING OVEN WITH DOUBLE DOORS

the machine as fast as they are made. It may be regarded as a foundry axiom that the only time a jarring machine is earning money for a foundry is when it is in use. What does it avail to ram a mold in less than a minute if a flask is not put on the machine every minute and one taken away?

In order to overcome this handicap, common to most all molding machine installations, K. V. Wheeler, the superintendent, devised the outfit shown in Fig. 1. In the background are two Davenport jolt-rollover draw machines. They are kept supplied with sand from the large hopper placed immediately above them. This hopper in turn is filled with sand by means of a grab bucket suspended from the crane. The machines of course may be fitted with any pat-

ate extends 20 feet past the molding machines on each side. The empty trucks are parked on one section of the track and the full ones on the other. When operating, an empty truck is brought up and spotted in front of the drag machine. The men jolt five drags and place them on the truck. Most of the flasks are handled by hand but for those that are too heavy for hand work an air hoist is available, as may be seen by referring to Fig. 1. When the five drags are on the truck it is pushed over in front of the cope machine. Here the men make five copes and place them on the drags, closing the molds. The truck load of molds is then pushed out to the end of the floor. When four or five loads are ready they are poured.

After the molds are poured they are stacked five high and carried away

the laboratory is on the upper floor. The rest of this section of the shop is taken up by the core room which is exceptionally well fitted up for handling small cores. A smooth concrete floor facilitates the loading and unloading of the ovens. The cores are placed in racks when they are made. When a rack is full a Barret-Craven truck is slipped under it and the rack is lifted off the floor and wheeled into the oven. Here the lifting mechanism is released, the rack set on the floor and the truck withdrawn. When the cores are dry this process is reversed.

There are seven ovens, all the same size, 4 x 5 x 5 feet. Two of them are heated by electricity, the other five by gas. The ironwork for the core ovens was fabricated by the National Machine Works, Chicago, and erected by the employes of the Electric Steel Co. A

Hardening Effect of Additions of Commercial Metals to Aluminum

Zinc Alloys

The hardening effect of zinc on aluminum is illustrated by the following tests according to the researches of P. Ludwik:

Alloy No. 1.	Per cent	Alloy No. 2.	Per cent	Alloy No. 3.	Per cent
Aluminum	96.00	Aluminum	92.00	Aluminum	85.00
Zinc	4.00	Zinc	8.00	Zinc	15.00

The specimens were tested for hardness by the conical impression test. The test pieces were cast in chilled iron molds, but as this would give a false value for aluminum, the specimens were annealed before being tested. Two tests were taken of each specimen; one after it had been softened by ordinary annealing, and the other after it had been annealed for a period of three hours at a temperature of 500 degrees Cent..

The hardness of No. 1, softened, was 41, and after long annealing 39.5. The hardness of No. 2, softened, was 48, and annealed, 54.5. The hardness of No. 3, softened, was 75, and annealed, 97.5. These figures are the average of two hardness tests.

Copper Alloys

The effect of copper in hardening aluminum is shown as follows:

Alloy No. 4.	Per cent	Alloy No. 5.	Per cent	Alloy No. 6.	Per cent
Aluminum	98.00	Aluminum	96.00	Aluminum	92.00
Copper	2.00	Copper	4.00	Copper	8.00

The hardness of No. 1, softened, was 50.5, and annealed, 57.5; of No. 2, softened, 64.25, and annealed, 86.5, and of No. 3, softened, 75.5, and annealed, 91.5.

Copper and Tin Alloys

When copper and tin were used together the hardening effect was as follows:

Composition			Hardness	
Aluminum Per cent	Copper Per cent	Tin Per cent	Chilled casting Softened	Annealed 3 hours at 400 degrees Cent.
92.00	4.00	4.00	68.00	71.5
88.00	4.00	8.00	69.50	70.0
88.00	8.00	4.00	80.50	79.5
84.00	8.00	8.00	84.50	83.0

The addition of tin it will be noted does not exercise any appreciable hardening effect on aluminum, while zinc is not as satisfactory as copper.

FORMULAS FOR THE BRASS FOUNDRYMAN

Hardening Effect of Additions of Commercial Metals to Aluminum

Magnesium Alloys

The effect of magnesium in hardening aluminum is illustrated by the following tests according to the researches of P. Ludwik:

Magnalium

	Per cent
Aluminum	98.00
Magnesium	2.00

The hardness of the chill-cast alloy, softened, was 57.5. When annealed at a temperature of 430 degrees Cent. for three hours, the hardness was 50.5. Other aluminum-magnesium alloys follow:

Alloy No. 1.	Per cent	Alloy No. 2.	Per cent	Alloy No. 3.	Per cent
Aluminum	96.00	Aluminum	92.00	Aluminum	85.00
Magnesium	4.00	Magnesium	8.00	Magnesium	15.00

Hardness

Alloy No. 1.		Alloy No. 2.		Alloy No. 3.	
Annealed	80.00	Annealed	100.50	Annealed	Not tested
Softened	80.00	Softened	102.50	Softened	148.50

Aluminum, Magnesium and Copper Alloys

Composition			Comparative Hardness	
Aluminum Per cent	Magnesium Per cent	Copper Per cent	Chilled castings Softened	Annealed 3 Hours at 400 degrees Cent.
95.50	00.50	4.00	77.50	108.50
96.00	2.00	2.00	86.50	100.50
94.00	2.00	4.00	101.50	132.50
94.00	4.00	2.00	99.00	66.50
92.00	4.00	4.00	116.50	102.00

The hardening effect of magnesium on aluminum is greater than that of either copper or zinc. The effect of the three elements is approximately, as follows:

To produce an alloy twice as hard as pure aluminum there is required zinc, 15 per cent; copper, 8 per cent; magnesium, 4 per cent. The hardening effect of magnesium is therefore, twice that of copper, and nearly four times that of zinc.

THE FOUNDRY DATA SHEET, JUNE 1, 1919
Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

Note—This sheet may cut into two sections, 5 x 7 inches, and may be readily bound in note book form.

variety of binders is used in mixing the core sand. For pouring-cups, and also for cores which form the outside of some part of a casting, and other cores of like character, Federal core compound is used quite extensively but most of the cores are made with Holland core oil as a binder. In like manner the proportion of new sand varies with the purpose for which the core is intended. One mixture consists of all new sand mixed in the proportion of one of oil to 25 of sand. This is an extreme case. At the other end of the scale, we find mixtures consisting of one part of dry core compound to 20 parts of old black sand. The core room is supplied with a 4-foot sand-grinding pan furnished by the National Enginering Co., Chicago, and two power riddles. One is of the gyratory type and the other of the oscillating type, both being manufactured by the Champion Foundry & Machine Co., Chicago.

Adjacent to the core room on the outside is a row of storage bins for holding foundry supplies. They are of sufficient capacity to hold a year's supply of sand for molding, coremaking and sand blasting together with clay, ganister, limestone, fluorspar, core binders, etc. A spur track runs alongside and the whole battery of bins is roofed over. The bins are open on the top but there is a leanto roof over them all, extending from the foundry wall well out over the track where it is supported on a row of pillars. The building is open at this side and at both ends. The pillars also serve as a support for a runway of a 10-ton Pawling & Harnischfeger yard crane. This crane operates a grab bucket for unloading the cars when they arrive with raw materials and also is used for loading the electric trucks which carry the sand, etc., into the foundry as it is needed.

The pattern and repair shop is situated in the angle formed by the two main buildings. It is 80 feet in length by 40 feet in width and is fitted up with all the necessary machinery for effecting repairs to both flasks and patterns, either in wood or iron. The millwright and electrician also have benches in this building to work at while repairing the machinery under their charge.

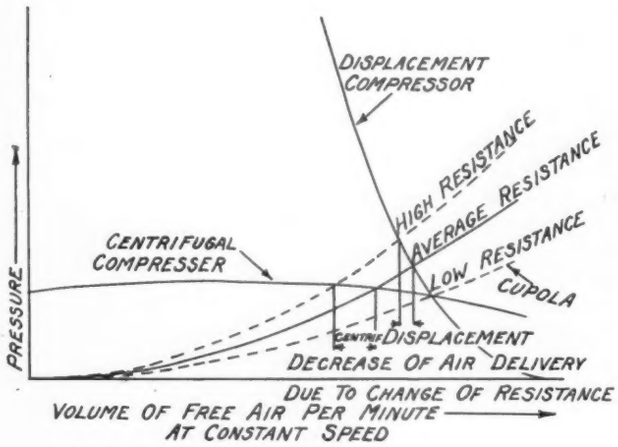
That part of the building shown at the right in Fig. 1, formerly constituted both foundry and chipping room. It is now given over altogether to the cleaning, chipping, annealing and shipping departments. Fig. 6 shows the approximate location of the different units in these departments. After the castings are shaken out some of them are cleaned in tumbling barrels and the rest are sand-blasted. Then they are inspected, the defective ones weeded out and the rest taken to the annealing furnace. There is a divergence of opinion among steel foundrymen as to the necessity of annealing all the castings. In this shop everything is annealed. On the way to the annealing furnace any of the castings with risers too large to be knocked off are taken to the oxyacetylene room where they are cut off.

The annealing oven is of the car type, 6 x 6 x 10 feet, with a door at each end; by this arrangement no heat or time is lost, for when one car is ready to come out another is ready to go in. The oven is heated with gas which enters through a series of ports along the top of the wall just under the roof. It is kept at a temperature of 1000 degrees Fahr. After the castings are placed inside, the temperature is gradually raised to 1600 degrees and held at that point for from two to three hours when it is allowed to drop back to 1000 degrees. After leaving the annealing furnace the castings are put through another pair of tumbling barrels to clean off the scale and polish them. From this point they are taken to the different grinders and chipping benches which may be seen in Fig. 8. The belts on all the grinding wheels are provided with wire guards which reduce the chances of accident to a minimum. These guards form part of the general policy of the management to have and maintain a clean and tidy establishment. To this end there are numerous signs displayed prominently inviting the co-operation of employes.

FIG. 8—ROW OF BENCH GRINDERS PROVIDED WITH EVERY SAFETY DEVICE

Reviews Accomplishment

"Ideals and Convictions" is the title of a booklet which has been prepared by Frank D. Chase, Inc., Chicago, industrial engineer. A series of single page talks on industry, manufacturing conditions and the scope of duty of the industrial engineer are presented. Interspersed with these are exterior and interior photographs of manufacturing plants recently constructed. These present some of the latest ideas in light and ventilation furnished through adaptations of monitor and saw-tooth type roofs.



APPLICATION OF CHARACTERISTICS

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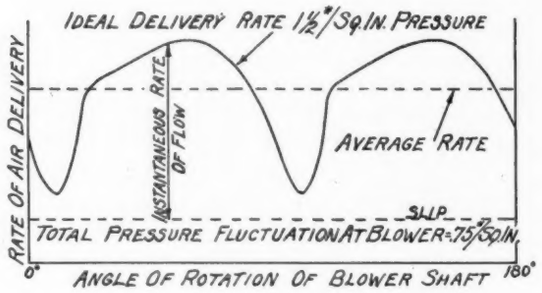
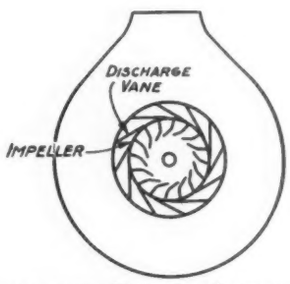


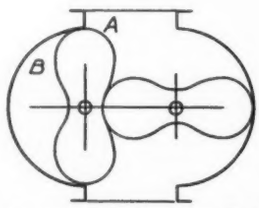
AIR DELIVERY FOR 24 OZ./SQ.IN. PRESSURE

2



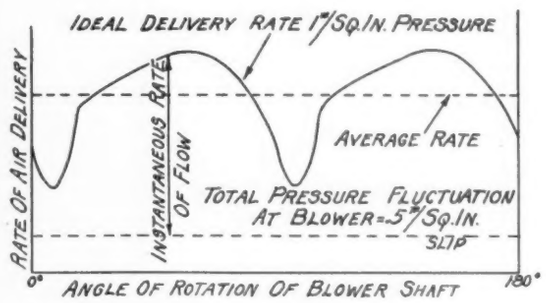
VELOCITY TYPE OR CENTRIFUGAL BLOWER

3



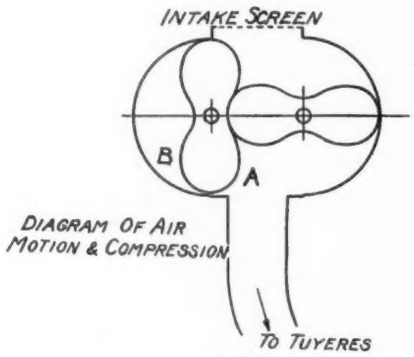
DISPLACEMENT TYPE OF BLOWER

4



AIR DELIVERY FOR 16 OZ./SQ.IN. PRESSURE

5



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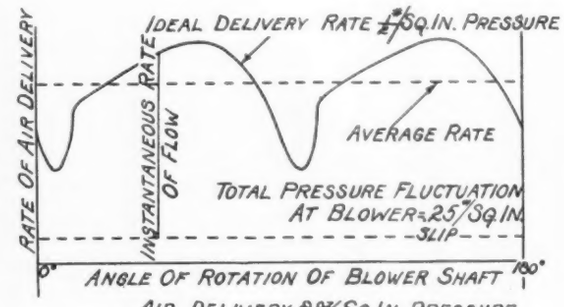
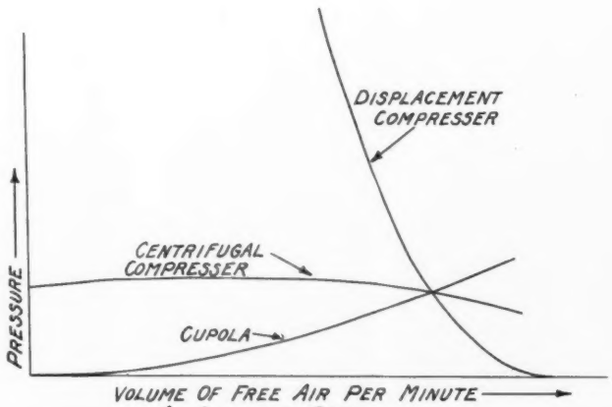


AIR DELIVERY 8 OZ./SQ.IN. PRESSURE

7



CHARACTERISTICS OF BLOWER AND OF CUPOLA

8

CHARACTERISTICS OF FOUNDRY CUPOLA BLOWER PRACTICE

Use of Displacement Blowers in Cupola Practice

The Different Characteristics of Displacement and Fan Blowers Are Described and Data Are Given for Correct Blower Sizes

By Prof W Trinks

IN the application of blowing equipment to cupolas, two questions invariably come up, namely how much air is required, and against what pressure must this air be delivered? It would be a great satisfaction to engineers and metallurgists if these questions could be answered on the basis of logical reasoning. The latter would probably run along the following channel: The melting and superheating of iron in the cupola requires a known amount of heat per unit weight of iron. The heat is furnished by the combustion of coke. However, only a fraction of the heat of combustion is available, varying with the composition and temperature of the flue gases. But the temperature and the composition of the flue gases depends upon the depth of stock or burden and upon the ratio of iron to coke. If the stock be shallow, holes or pipes are formed through which the air rushes, burning the carbon to dioxide, oxidizing the iron and carrying off large quantities of heat by the large amount and high temperature of the flue gases. If on the other hand the stock be quite deep, the cupola is converted into a gas producer. Carbon is burnt incompletely and large quantities of combustible (carbon monoxide) are practically wasted by passing up the stack.

Somewhere between the extremes, there lies a best condition, which, unfortunately, cannot be determined from theory alone, because the interaction between glowing carbon, oxygen, carbon monoxide and carbon dioxide is so complicated as not to be amenable to mathematical treatment. The best depth of stock, and the smallest ratio of coke to iron must, therefore, be worked out from careful experiments in practice. A tabulation of the data gained from experience is given in the table that accompanies this paper.

Regularity an Important Factor

It is important that these best values which have been determined by experience should be maintained during the melting operation. This means that the rate of charging, the rate of combustion and the rate of melting must be constant and regular. For the latter requirement, a constant delivery of blast is sufficient and necessary.

With apologies to those who are thoroughly familiar with air moving apparatus, the positive displacement and centrifugal types of blowers are shown in Figs. 3 and 4. Fig. 8 gives the characteristics of the two types of blowers, by which word is meant the curve expressing the relation between *volume of air delivered by the blower* and *discharge pressure*, both for a given intake pressure and for a given speed of the machine. It will be noted that for a given change of pressure, the delivery of the centrifugal machine varies much more than that of the displacement machine. The same illustration also contains the characteristic of a cupola for a given depth of stock, given brand of coke, etc. By characteristic of a cupola is meant the curve showing how the pressure at the wind box varies, if more and more air is delivered to the cupola. This curve is parabolic in character. The point where the cupola characteristic and the blower characteristic intersect determines the pressure and the air delivery which are established.

Fig. 1 is a duplicate of Fig. 8, except that several other cupola characteristics have been added. These characteristics belong to different depths of stock in the cupola. It is evident that the resistance to flow is greater with a deep burden than it is with a low burden. The cupola characteristics have been marked low resistance, average resistance, high resistance. For the sake of simplicity, assume that charging is practically continuous. Also assume that, for some reason or other, the resistance to flow through the cupola is temporarily increased, for instance by slag clogging up a tuyere. Then the air delivery is decreased a small amount, if the displace-

From a paper presented at the meeting of the American Foundrymen's association held at Milwaukee. The author is connected with the Carnegie Institute of Technology, Pittsburgh.

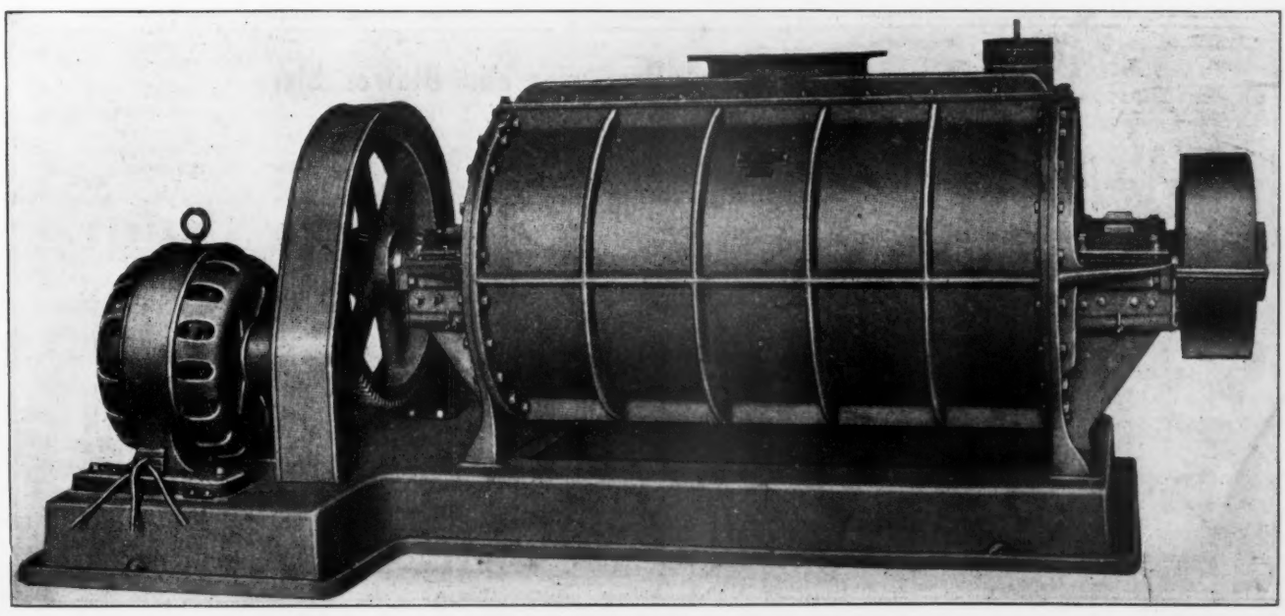


FIG. 9—SELF-CONTAINED, MOTOR-DRIVEN BLOWER OF THE DISPLACEMENT TYPE

ment machine is used, and a much larger amount if a centrifugal machine is used. The immediate consequence is a growth of the depth of the stock, because decreased air delivery means lower rate of combustion, and because the melters keep on charging as before. But a higher stock line means still greater increase of resistance, further reduction of the air delivery, further reduction in the rate of combustion, etc., in a cumulative manner.

The cumulative effect is pronounced with a centrifugal blower. According to the diagram, Fig. 1, a similar effect should be noticeable with the displacement blower, except that its lack of stability should be smaller and in consequence the changes in rate of delivery should be very much slower. The feature causing this difference is vibration in the discharge line of any displacement blower.

The vibration is caused by the circumstance that the space *B* in the position shown in Fig. 6 carries atmospheric pressure, while the space *A* carries discharge pressure. An instant later *B* is in communication with *A* and a weight of air depending upon the pressure difference between the discharge and the inlet rushes back into *B* until the pressures are equal. Evidently, the delivery of air is diminished during the period of flow-back or of pressure equalization. Figs. 7, 5 and 2 show the ideal rate-of-delivery curves for ½-pound per square inch, 1 pound per square inch, and 1½ pounds per square inch pressure in the delivery pipe. In these illustrations are likewise indicated the pressure fluctuations which under average cupola service conditions establish themselves as a direct result of the vibrating rate of delivery. While, in some kinds of blower service a steady stream of air with little or no vibration may be desirable the same vibration is extremely beneficial in cupola operation. It should be noted that the vibration can be practically eliminated in cases where its presence is harmful by forming the discharge end of the blower in the shape of an air chamber.

Going back to the example of a slight increase in the resistance to flow, caused for instance by the clogging up of a tuyere, it follows from Fig. 1 that the air delivery with a displacement blower drops only a little. It also follows from the same illustration that the pressure rises considerably. And finally, it follows from Figs. 7, 5 and 2 that the pressure fluctuation or vibration grows. But the combined effect of greater pressure and of greater vibration loosens the stock in the cupola to such an extent that the resistance is quickly restored to its original value.

Inversely, should the resistance drop below the normal value, then the pressure will drop considerably, and the vibration will decrease, all of which tends to bring the resistance back to its former value.

Blower Must be of Proper Size

While the displacement blower makes for stable and steady operation of the cupola, it is important to select the right size of blower for the cupola so as to utilize to the fullest extent the self-regulating properties of the displacement machine. It should be noted that most blowers are now motor-driven and that with increasing centralization of power generation more and more of the motors are of the alternating current type. But in this latter type, speed adjustment without loss is impracticable, except in large units where initial expense counts little compared to what may be saved in operation.

In the sizes of alternating current motors which are used in connection with foundry blower service, the speed can never be increased over the economical speed, and can be reduced only at the expense of continually dissipating electric energy.

The accompanying table on cupola practice, which was furnished by the Whiting Foundry Equipment Co., Harvey, Ill., will be of assistance in this connection.

If a mistake should have been made in the selection of the size of the blower, as a rule it is cheaper to change the gears or pulleys between the motor and the blower than to put up with the continued losses day by day. For, if the blower is too small, the melting capacity is reduced, which means a loss in tonnage, and if the blower is too large too much heat goes up the stack, while the iron is oxidized. These losses can be avoided by opening a bypass on the blower, but that means loss of power and interference with the self-regulating features of the blower. However, there is really no excuse for selecting the wrong size of blower, except perhaps the necessity of buying a second-hand machine to avoid initial expense. But usually the purchaser in such a case pays dearly in the long run for the initial saving.

Positive displacement blowers for cupola service are reliable machines and every case of trouble can be traced usually to one of two causes: Either the machine was not set properly, or else there existed utter lack of even the first elements of care and attention.

Let us take up these two points in the order given. It will not do for instance to support the blower, Fig. 9, at the right hand end only and to leave

Recommended Charges, Pressures and Blower Sizes

Dia. inside of lining, in.	Thickness of lining, in.	Dia. of wind box, in.	Dia. of shell, in.	Area ins. lining sq. in.	No. of tuyeres	Total area of tuyeres, sq. in.	Cap'r tons-hr.	Bed lbs. With upper tuyers Coke	Bed lbs. With upper tuyers Iron	Bed lbs. Without upper tuyeres Coke	Bed lbs. Without upper tuyeres Iron
18	4½	..	27	254	2	32	¼-½	150	375	.....	.....
23	4½	46	32	415	4	83	½-1	250	625	.....	.....
27	4½	50	36	572	8	114	1-2	400	1,000	350	875
27	7	57	41	572	8	122	1-2	450	1,125	350	875
32	4½	57	41	804	8	122	3-5	600	1,500	500	1,250
32	7	62	46	804	8	161	3-5	650	1,625	500	1,250
37	7	67	51	1,075	8	182	5–6	850	2,125	650	1,625
42	7	74	56	1,385	12	270	6-7	1,100	2,750	900	2,250
45	9	81	63	1,590	12	312	7-9	1,250	3,125	1,100	2,750
48	9	84	66	1,809	12	347	9-10	1,450	3,625	1,300	3,250
54	9	92	72	2,290	12	468	10-12	1,900	4,750	1,700	4,250
60	9	98	78	2,827	12	546	12-14	2,450	6,125	2,100	5,250
66	9	104	84	3,421	12	642	14-18	3,000	7,500	2,750	6,875
72	9	112	90	4,071	12	828	18-21	3,750	9,375	3,400	8,500
78	9	118	96	4,778	12	945	21-24	4,400	11,000	3,900	9,750
84	9	124	102	5,541	12	945	24-27	5,100	12,750	4,650	11,625
87–90	9 or 10½	130	108	6,361	16	860	27-31	5,500	13,750	5,000	12,500

Other charges, lbs. Coke	Iron	Flux Limestone	Air Blast press. oz.	Air Cubic ft. per min.	Air Blast pipe dia.	Positive pressure type blower Size	Sp'd	Hp.	Nozzle dia., in.
40	400	6	7-8	300	4*	¼	415	0.9	5
60	600	9	8-10	600	6⅜	1	245	2.2	8
80	800	12	8-10	1,000	10	1–2	385	3.5	8–10
							245	3.5	
80	800	12	8-10	1,000	11¾	2	245	3.5	10
110-120	1,200	18	10-12	2,500	11¾	3	335	10	12
110-120	1,200	18	10-12	2,500	14	4	235	11	14
140-160	1,600	25	10-12	3,000	14	4	255	12	14
180-200	2,000	30	12-14	3,500	14	4–5	295	16.0	14–16
							205	16.7	
210-230	2,300	35	12-14	4,500	17	5	255	21	16
240-260	2,600	40	12-14	5,000	17	5½	195	22.8	18
300-330	3,300	50	12-14	6,000	18⅛	5½	230	27	18
370-410	4,100	60	14-16	7,000	18⅛	6–6½	195	35.5	20–22
							150	36.4	
450-500	5,000	75	14-16	9,000	24⅞	6½–7	190	46.2	22–24
							158		
550-600	6,000	90	14-16	10,000	24⅞	7	175	51.2	24
630-700	7,000	100	14-16	12,000	24⅞	7½	158	60.7	24
730-800	8,000	120	14-16	13,500	24⅞	7½–8	177	68.5	24–30
790-870	8,700	130	14-16	15,000	30	8	144	76	30

*Two.

it unsupported at the left, because in no type of machines are bedplates made rigid enough to take up overhanging weights without deformation. The manufacturer who made bedplates rigid enough for taking up overhanging weights or foundation bolt pull without deformation would soon go out of business, because his machines would be so heavy as to make the price prohibitive. In consequence, bedplates are made strong enough to bridge over small irregularities in the support. Hence, a blower must not be set up on an irregular surface and then bolted down. It should touch the supporting surface in several places, not too far apart, before the bolts are tightened. If necessary, iron wedges may be used.

In foundry practice, it has more and more become customary to place the blower on the charging platform, to take air in from above and to discharge it downwardly toward the tuyeres. This arrangement saves much space and takes the blower away from the dirt of the floor. With this arrangement it is desirable to make the structural material supporting the blower rigid—so rigid that no deformation can take place. This goal is reached if the girders are figured from structural tables to support a weight of four to five times that of the complete blower, bedplate and motor. It must be remembered that clearances in bearings are a few thousandths of an inch and that deformation of a few thousandths will, for that reason, cause heating and excessive wear.

Care and Attention Necessary

A similar condition exists with regard to pipe connections. Piping which has to be pulled into place by bolts deforms the casing of the blower and may cause touching of the impellers in spots. All of these precautions should be observed just as much for centrifugal blowers and pumps as they should be for displacement blowers. In fact, I have experienced trouble with improperly set centrifugal pumps.

The second feature is one of care and attention. No matter how much we may strive to make machinery foolproof, it will require some attention. Positive displacement blowers have self-oiling bearings which are closed against dirt and dust, and have self-oiling gears. And yet, with all these precautions, the lubrication is not that of the ideal oil bath, which is the dream of every designer of machinery. Accordingly, slow wear occurs. Every few months the dirty oil must be drawn off and replaced by clean oil. The machine should be inspected at least once a week to see whether wear may have taken place due to some unforeseen reason. Undue wear can usually be discovered from the color of the oil, or from a scraping noise of the impellers in the casing.

Once a year the inlet screen should be removed, the impellers should be placed vertical, one after the other, and the clearance between the top of the impeller and the casing should be checked up. The bearings are adjustable so that the correct clearances can easily be re-established if wear should have occurred. By adjustment before excessive wear takes place much is saved.

Philadelphia Foundrymen Hear Building Lecture

INTEREST in the approaching annual convention of the American Foundrymen's association in Philadelphia is acting as an added incentive to attendance at the regular meeting of the Philadelphia Foundrymen's association. Remarks by President Thomas Devlin and Secretary Howard Evans, with respect to the recent death of Stanley G. Flagg Sr., featured the meeting of May 7. Mr. Devlin, who personally has spent 65 years in the foundry business in Philadelphia, alluded to Mr. Flagg, who was 89 at the time of his death, as one of the pioneer malleable iron founders in that district. Mr. Flagg, he said, first began the manufacture of fittings in 1854. At that time he rented a room at the plant of the Philadelphia Hardware and Malleable Iron works, which he devoted to the finishing of castings made for him by that interest. Later Mr. Flagg took steps toward the establishment of his own foundry and his business finally developed into the large plant now operated by Stanley G. Flagg & Sons Co., Pottstown, Pa. It was pointed out by Mr. Devlin as a matter of interest that Mr. Flagg, when he first began to market his fittings, sold them at 33 cents per pound.

Oliver D. Conover, Austin Co., Cleveland, addressed the meeting on "Iron, Brass and Steel Foundries and Their Building." He spoke specifically on the possibilities of the standard-unit type of building for foundry purposes and his talk was accompanied by a large number of lantern slides showing foundries of all kinds in all stages of construction. Before proceeding to the erection of a new foundry, Mr. Conover said, it is necessary, in selecting the best type and arrangement of building, to digest numerous factors such as the kinds of metals cast, the character of the castings, whether the foundry is to be a jobbing or specialty shop, whether melting is to be done in the cupola, converter, crucible, open-hearth or electric furnace, and many other questions. In some cases it is necessary, by reason of special conditions, to evolve a building of a special character. In most cases, however, some adaptation of a standard type will serve. Mr. Conover pointed out the numerous features of the standard-unit type of construction by which provision may be made to house almost any kind of manufacturing arrangement. Due to the thoroughness with which all details of these buildings have been worked out, it is possible to order all parts of the structure within three hours after the order is booked, and so well trained have the erectors become, that it now is possible to erect such buildings in a short time.

"The modern method of plant operation," he said, "requires a systematic plan, that is, a standard method of routing the work. As is well known, this has been carried so far in some foundries that the orders are entered, schedules arranged and patterns specially selected so that the foundry superintendent may plan his work only as the production manager prescribes, and cannot select the class of work which would show the best results for a quantity or tonnage basis, which is the case in many instances. By deviating from such systematic methods, the chances for repeat orders have been jeopardized because deliveries and promises have not been kept. Therefore, systematizing or standardizing of plants is essential and this fact must be borne in mind in designing the building, locating the cranes, providing for the distribution of the foundry equipment and arranging for the continuous movement of materials from the raw to the finished state."

Because of the flexibility of standard buildings, with reference to their use in the various industrial trades, Mr. Conover said, it is possible to dismantle and re-erect in such a way as to change the entire character of the building. In response to questions, Mr. Conover stated that the life of these buildings is estimated at 20 years, but he told of some foundries, notably one of the Alliance Machine Co., Alliance, O., where despite the fact that the structural steel originally was not painted, its condition continues excellent although the building was erected more than 20 years ago.

The purpose of the monitor type of

(*Concluded on page* 364)

THE FOUNDRY

A semimonthly journal devoted to all branches of the foundry trade

Published by

The Penton Publishing Co.

Penton Building, CLEVELAND

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Contents

	Page
Where Power Transmission Machinery is Made	325
Addresses Newark Foundrymen	328
Electric Furnace for Melting Nonferrous Metals—II	329
Elementary Points on Core-Making	333
Steel Foundry Opened in Wilkes-Barre, Pa	334
Stove Manufacturers Discuss Export Problems	335
Making Castings Used in Ship Construction—II	336
Methods for Reducing Casting Losses	339
Bill Fishes and Talks Brass Founding	341
New Method for Determination of Phosphorus	343
Factors in Selecting the Proper Core Binder	344
Should Use a Slag Hole	344
Can a Propeller Mixture be Melted in the Cupola?	349
Mixture for Trolley Wheels	349
Exceptional Alloy Sought	350
Melting With Low Sulphur Fuel Oil	350
Melting Brass for Heavy Castings	350
Difficulties with Alloys of Copper and Lead	350
What is Benedict Nickel	350
Philadelphia Convention Plans Taking Shape	351
Electric Steel Castings Made in Chicago Shop	352
Reviews Accomplishment	355
Use of Displacement Blowers in Cupola Practice	357
Philadelphia Foundrymen Hear Building Lecture	359
What Four Practical Men Can Do	360
Why Not More Foundry Research	360
Trade Outlook in the Foundry Industry	361
Comings and Goings of Foundrymen	362
Develops Shaft Drive Swing Grinder	363
Builds New Core-Room Tool	364
What the Foundries Are Doing	365
New Trade Publications	366

What Four Practical Men Can Do

A CERTAIN amount of system is necessary in any business. It forms the base on which the business rests. But it must be kept within reasonable bounds. Red tape may be beautiful, but unless it is constantly trimmed it will enmesh the productive functions of any industry in its crimson grasp and throttle the life out of it. The foundry business is no exception. There is a foundry in this country which sells $250,000 worth of castings a month. Outside the four practical men in charge there is an office force of eight people. This may be considered the very highest point of efficiency. There are other foundries not doing one-third the business which carry office forces ranging from twenty to fifty. It is all a question of the executives being able to dispose of a mass of detail without finding it necessary to delegate an understudy to look after each item. A thorough understanding of the different factors involved in the production of castings makes it a relatively easy matter to so route the work that a large amount of detail can be combined and attended to by a comparatively small force. It goes without saying that the same system would not fit every plant. The principle, however, is always the same. The system must be simple, it must be direct, it must be based on practice not theory, and finally once adopted it should not be changed except under the gravest circumstances and after the most mature consideration.

Why Not More Foundry Research?

RESEARCH laboratories pay. Otherwise big companies would not continue to support them. But the large industrial works is not the only place where research is highly thought of. All of our leading universities carry on research work and offer their facilities to the individual inventor to enable him to follow out his investigations. In addition there are the combinations of small manufacturers which support a central laboratory to help them all solve their problems and to refine and improve their methods. Some large foundries also carry on a limited amount of research investigation and in one case a number of foundries have pooled their interests along this line.

If this work has proved itself to be so valuable to various industries, why shouldn't the foundries of the country create an organization from which they could obtain the full benefit of co-operative research? Each branch of the industry, for instance, the steel, gray iron, malleable iron and brass foundries could get together and support a central research foundry. Such a foundry besides making metallurgical investigations, could work out the best methods for molding certain castings which are generally made in all parts of the country. Incidentally this foundry could be used to train first-class molders to be sent into shops of member companies and give them the benefit of their skill and training. It does not take much of an improvement to effect a saving of a few thousand dollars a year in a foundry; and there are few if any foundries in which a thoroughly trained expert could not make substantial improvements. If half the foundries in the country would form such an association or make use of an existing organization, the benefits of research would soon become apparent.

Trade Outlook in the Foundry Industry

BUSINESS weather-vanes, which for the past two months have pointed unswervingly toward fair winds in practically all manufacturing lines, are vindicated by the present trend in the foundry industry. With few exceptions inquiry is heavy and a volume of orders approaching closely to the percentage which would normally be expected from this inquiry is at hand. Light gray-iron shops, jobbing foundries and malleable plants are experiencing the more rapid acceleration, and those establishments which support the automobile lines are in the lead. Eastern foundries engaged in miscellaneous machinery lines, and cast-iron pipe shops in both the East and South report brightening prospects.

Heavy Casting Reluctant

Shops engaged largely on heavy work, particularly those building frames for heavy machinery have not yet felt the strengthening demand. Marine-engine work, too, is marking time although eastern foundries, particularly those in eastern New Jersey, are booking orders at 4½ to 5 cents per pound. In this connection it is noted with interest that British shipbuilders are reported reluctant to accept new contracts at less than $180 per ton with delivery from 19 to 24 months in advance. Two responsible shipyards in this country have offered to build vessels at $145 to $149 per ton respectively, and delivery is possible under six months. With the world demand for shipping the opportunity offered American shipbuilders is unprecedented, and carries with it a prospect for continued activity on the part of those foundries which have proved their aptitude in heavy marine casting work. Southern cast-iron pipe foundries continue at or near full production and cast scrap still is finding preference over pig iron where available for this class of work, due to the difference in price. Pig-iron production is at a low point with no marked change in price. The inquiry for foundry grades indicates a continuation of buying only for immediate needs, but the combined volume taken together as an index proves that gray-iron foundries are receiving heavier orders. The building impetus both in manufacturing and housing construction has brought forth a heavy inquiry within the past two weeks. Stove and furnace casting plants are actively engaged, while jobbing foundries which handle special industrial furnace work report a large number of inquiries. The smelting interests in the East, through the Central West and in Canada are expanding their facilities and specifications for furnace construction are now in many construction offices. Municipal castings, too, are showing greater strength. The larger centers all are experiencing a shortage of housing facilities. Real estate operators are taking steps to meet this shortage regardless of the prevailing high prices in building materials. This movement eventually will reach the shops making all classes of municipal castings, as well as those which specialize on domestic iron supplies.

Prices of Raw Materials for Foundry Use

CORRECTED TO MAY 26

Iron		Scrap	
No. 2 Foundry, Valley	$26.75	Heavy melting steel, Valley	$15.00 to 15.50
No. 2 Foundry, Birmingham	26.75	Heavy melting steel, Pittsburgh	15.50 to 16.00
No. 2 Foundry, Chicago	26.75	Heavy melting steel, Chicago	15.00 to 15.50
No. 2 Foundry, Philadelphia	28.35 to 29.85	Stove plate, Chicago	17.50 to 18.00
Basic, Valley	25.75	No. 1 cast, Chicago	22.00 to 22.50
Malleable, Chicago	27.25	No. 1 cast, Philadelphia	21.00 to 22.00
Malleable, Buffalo	27.25	No. 1 cast, Birmingham	20.00 to 22.00
		Car wheels, Iron, Pittsburgh	21.00 to 22.00
Coke		Car wheels, Iron, Chicago	20.00 to 20.50
Connellsville foundry coke	4.50 to 5.00	Railroad malleable, Chicago	16.75 to 17.25
Wise county foundry coke	6.00 to 6.50	Agricultural malleable, Chicago	16.25 to 16.75

Steel Demand Light

The steel casting line continues slack as compared with other branches of the foundry industry and with conditions obtaining previous to the armistice. The average operation is said to range as low as 40 per cent of the production previous to Nov. 11. It is generally believed, however, that the general business activity imminent carries a volume of demands which have been withheld. Those companies which specialize in tractor work note an increase in demand for steel castings. It is confidently expected that the sale of tractors will grow steadily through the summer. One large manufacturer with a present output of about 25 machines per day is so confident of the soundness of this opinion that an expansion to produce 100 tractors per day is under way.

Nonferrous foundry activity as reflected in the markets is practically the same as has obtained for the past two months. Plumbing supplies furnish the heaviest consistent demand. Casting copper is quoted at 16.25c, New York. Prices on other nonferrous metals based on New York are: Lead, 5.25c; tin, 72.5c; antimony, 8c to 8.25c; aluminum, No. 12 alloy, producers' price, 31.50c, and open market, 26c. Spelter is quoted at 6.25c, St. Louis. At a meeting of the National Association of Brass Manufacturers which was held recently, it was decided to continue the policy of standardization which was inaugurated during the war. This has resulted in the reduction of some 4000 lines of brass lavatory and laundry fixtures to about 1000 standard pieces. The announcement of this policy is expected to bring on a considerable volume of orders which have awaited the certainty that the present lines would not be changed.

Malleable Operations

Practically all sections report improved business in the malleable plants. The implement lines which have been holding back the general average of operations are improving. The district around Chicago which supplies a large part of the implement manufacturing industry in the Mississippi valley has felt the impetus and expects an even greater demand. The automobile shops have inquiries in advance of their capacity in many cases, with the continued prosperity in all automotive lines as a guarantee of yet greater demand. In the East where the demand for malleable castings is more diversified, a marked improvement is noted. General machinery lines together with a fair amount of automobile business is maintaining the malleable average at between 70 and 75 per cent.

COMINGS AND GOINGS OF FOUNDRYMEN

ARTHUR E. BARLOW who recently was elected president of the Newark Foundrymen's association for the third successive term has been actively engaged in the foundry business for the past 34 years. Starting immediately after his graduation from the Newark academy he worked for several years at various occupations which gave him wide practical foundry experience until in 1894, with the late William G. Morris, he purchased the Barlow, Condit and Morris foundry of Newark. In 1907 the company was incorporated as the Barlow Foundry Co. and later this incorporation was changed to the Barlow Foundry Inc. Mr. Barlow served as secretary of the Newark association for 12 years. Two years ago he was elected president which office he has filled continuously until his recent re-election for the third time.

S. A. Splain has taken charge of the foundry of the Stockton Iron Works, Stockton, Cal.

Roy W. Wallace has disposed of his interests in the Wallace Machine & Foundry Co., Lafayette, Ind.

F. Stiehl, Melinas, N. Y., has been appointed superintendent of the Vermillion Malleable Iron Co., Hoopeston, Ill.

George DuFour recently has accepted a position as coreroom foreman for the Nash Motor Co., Kenosha, Wis.

Chester K. Brooks, formerly in charge of the research department of the National Malleable Castings Co., Cleveland, has been made assistant manager at the Cleveland works.

Blaine H. Miller, formerly city commissioner of buildings for the city of Indianapolis has been made manager of the American Foundry Co. of that city.

Alexander McCarty, formerly with the New Jersey Art Metal Mfg. Co., Newark, N. J., has been made superintendent of the E. & T. Fairbanks Co., St. Johnsburg, Vt.

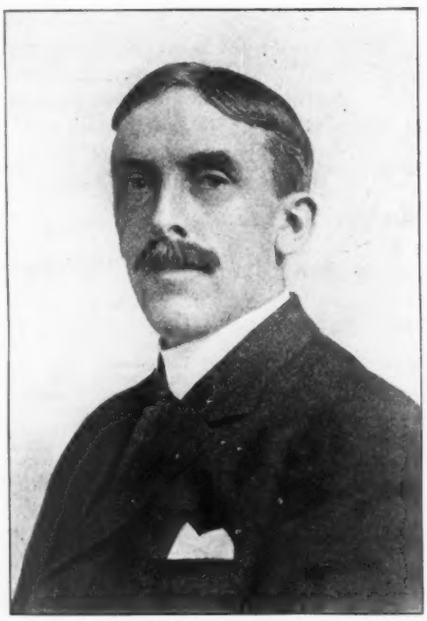
C. S. Daniels, formerly associated with the Burnside Steel Co., Chicago, has been appointed purchasing agent for the Chicago Electric Steel Co., 447 Kensington Ave., Chicago.

Thomas E. Fisher recently accepted a position with the Traylor Engineering & Mfg. Co., Allentown, Pa. He formerly was connected with the Wharton Steel Co., Wharton, N. J.

Robert F. Nachtrieb, formerly in the treasurer's office of the National Malleable Castings Co., Cleveland, and who recently returned from overseas service, has been appointed treasurer of the Toledo, O., works.

George F. Wilhelmy who for the past 10 years has been connected with the New York office of the National Mallable Castnigs Co., Cleveland, has been transferred to the sales department in the home office.

John Detthart, formerly foundry superintendent for the Alamo Engine



ARTHUR E. BARLOW

Co., Hillsdale, Mich., has been appointed assistant to R. J. McSherry, foundry superintendent of the Hercules Gas Engine Co., Evansville, Ind.

Lieut. Col. T. S. Hammond has obtained his release from the army following his return from over-seas service, and has resumed his duties as secretary of the Whiting Foundry Equipment Co., Harvey, Ill.

William H. Dosey, head instructor at the foundry of Carnegie Institute of Technology, Pittsburgh, has been appointed assistant in the training method section of the training service of the federal department of labor.

Ed Herron, for many years manager of the American Brake Shoe & Foundry Co. plant at Chattanooga, Tenn., has resigned to become manager of the recently organized Southern Machine Co., of that city.

William W. Sanderson, for the past 10 years Pittsburgh district sales manager for the Carborundum Co., Niagara Falls, N. Y., has been made general sales manager of the company and assumed his new duties on May 19. O. C. Dobson has been appointed in charge of the Pittsburgh office.

G. E. Scott has resumed his duties as vice president of the American Steel Foundries, Chicago, after 18 months' service in the American Red Cross, first as assistant general manager and since September, 1918, as general manager at Washington.

William Barry, formerly superintendent of the Monarch Steel Castings Co., Detroit, has assumed his duties as superintendent of the Pittsburgh Iron & Steel Co., Midland, Pa. Mr. Barry succeeds Frank D. Egan, recently resigned.

R. E. Prussing, recently discharged from the army with the rank of captain, has been appointed to his former position in charge of the Detroit office of the Whiting Foundry Equipment Co., Harvey, Ill.

N. C. Martin has been appointed purchasing agent for the Hercules Buggy Co. which controls the Hercules Body Co., and the Hercules Gas Engine Co., Evansville, Ind., producers of cylinders and gray-iron castings.

F. J. Tone has been elected president of the Carborundum Co., Niagara Falls, N. Y., succeeding the late Frank W. Haskell. The office of vice president left vacant by Mr. Tone has been filled by the election of George R. Rayner, formerly secretary and general sales manager.

J. W. Oliver, formerly branch manager at the Louisville, Ky., plant of the Standard Sanitary Mfg. Co., Pittsburgh, has been made secretary and a director of the company. He will be succeeded at Louisville by H. S. Tschopik who has been branch manager at New Orleans.

J. M. Donnelly, who has been connected with the engineering department of the Continental Motors Corp. at its Muskegon, Mich., plant for the past eight years, and with the company for 13 years, has resigned to become manager of the Master Pattern Co., of that city, which will specialize in metal patterns for gasoline engine parts.

S. Griswold Flagg, III, of Stanley G. Flagg & Co., Philadelphia, has been appointed a director of the American Foundrymen's association to fill an unexpired term. Mr. Flagg has been prominently identified with the activities of the American Foundrymen's association for a number of years, especially in connection with its technical work in the malleable iron field.

Harrison E. Howe has resigned as manager of the commercial department

of Arthur D. Little, Inc., chemists and engineers, Cambridge, Mass., to take charge of the research work of the National Research council which has been organized by the five national engineering societies. Herbert L. Sherman succeeds Mr. Howe in the Arthur D. Little organization.

F. A. Winchell and Oliver Winchell recently purchased the holdings of James T. Stubbs in the Central Texas Iron Works, Waco, Tex., and are preparing to increase the facilities of both the foundry and machine shop departments. Oliver Winchell is acting as superintendent until a suitable successor can be found to take charge.

J. Lewis Hay, Hay Foundry & Iron Works, Newark, N. J., has organized a group of foremen to study modern production methods. The object of the course is to train the men in the principles of leadership and to give them a broad view of their work and of the industry as a whole. The course is under the direction of John Calder, mechanical engineer, 185 Madison avenue, New York City.

J. S. Clay, formerly superintendent of the American Foundry Co., Indianapolis, has been made superintendent of the Connersville Casting Corp., formerly the Hoosier Castings Co., Connersville, Ind. George Pfeilshifter who was superintendent for the Hoosier Castings Co., returns to Indianapolis as superintendent of the core department of the American Foundry Co., a position which he held for a number of years.

George A. Harder recently was elected president and a director of the Central Foundry Co., New York, and its subsidiary companies. Mr. Harder is president of the Essex Foundry Co., Newark, N. J., and during practically his entire life he has been identified with the foundry industry. His father, Victor C. Harder, during his lifetime was head of the Monitor Iron Works, Newark, N. J., which has been one of the component parts of the Central Foundry Co. for over 20 years. Mr. Harder succeeds DeCourcey Cleveland whose resignation as president of the Central Foundry Co. became effective May 1.

F. A. Bennett and E. E. Seeley have formed a partnership under the firm name of Bennett & Seeley, with offices at 315 Court Exchange building, Bridgeport, Conn., and will handle a complete line of foundry and electro platers' supplies. Mr. Seeley has followed this business locally for some years, while Mr. Bennett, who is secretary of the Bridgeport Manufacturers' association, will continue actively to fill that office.

OBITUARY

David T. Richards, aged 48 years, president of the Hill & Griffith Co., Cincinnati, manufacturers of foundry equipment, died at a hospital in New York City on May 12, following an acute attack of appendicitis.

Starr H. Barnum, founder of the foundry conducted for 50 years under the name of S. H. Barnum, New Haven, Conn., died recently at his home in that city, aged 86 years.

Col. Clarence E. Burke, formerly vice president of the Lake Shore Foundries and one of the organizers of the United States Cast Iron Pipe & Foundry Co., died May 9, at his home in New York, aged 69 years.

Maj. Edward P. Reichhelm died recently at his home in Bayonne, N. J., aged 76 years. Following the Civil war Mr. Reichhelm invented several tools which led in 1876 to the organization of E. P. Reichhelm & Co. In 1879 he invented a gas furnace for melting metals. This invention led to the formation of the American Gas Furnace Co. In 1900 he organized the American Swiss File & Tool Co. to apply his gas furnace system to the preparation of metals for the manufacture of fine files.

BELT DRIVEN SWING GRINDER PROPELLED DIRECTLY THROUGH ROTATING SHAFT

Germany Becomes Mineral Pauper

According to a paper by Professor Beyschlag, head of the German Geological institute, that country is greatly dependent upon foreign minerals of all classes. Hopes placed in discoveries of gold and platinum have proved groundless. Tin, nickel, chrome, vanadium, wolfram and molybdenum also are stated to have been much overestimated. Germany has only one nickel mine producing about 500 tons per year. This is located in Silesia. Previous to the war, Germany manufactured about 260,000 tons of copper annually, of which she produced only about 30,000 tons. During the war aluminum was substituted for over a third of the copper requirements. The peace settlement clips from German control over 21,000,000 tons of a total of 28,600,000 tons of iron reported in 1913.

New Shaft Drive Swing Grinder

The accompanying illustration shows a new type of flexible swing grinder manufactured by the Manhattan Machine & Tool Works, Grand Rapids, Mich. This tool is designed for belt drive, and is rigidly supported upon a pedestal. The drive shaft is carried upon two main bearings at the two sides of the belt pulley, and a sleeve with a slotted keyway in the shaft permits it to be slipped 12 inches longitudinally. A flexible universal coupling which is fully enclosed allows the arm to travel over a 36-inch swing. The swing shaft is 7 feet, 8 inches long. The machine is designed to operate at a speed of 1600 revolutions per minute with a 12-inch wheel. Lubrication is secured through a system of wick oilers and drip cups.

New Method for Determination of Phosphorus

(*Concluded from Page* 343)

too prolonged or tin will be precipitated and will be difficult to redissolve.

A comparison of the method has been made with a gravinetric method, in which the tin oxide containing the phosphorus is mixed with Hepar mixture and fused. The resulting melt is dissolved in hot water, the solution acidified with a little hydrochloric acid whereby the tin is precipitated.

The tin sulphide is allowed to settle, and is then filtered off, the filtrate being boiled to remove sulphuretted hydrogen; nitric acid is added and taken down to low bulk, and the phosphorus precipitated and estimated as magnesium pyrophosphate in the customary manner.

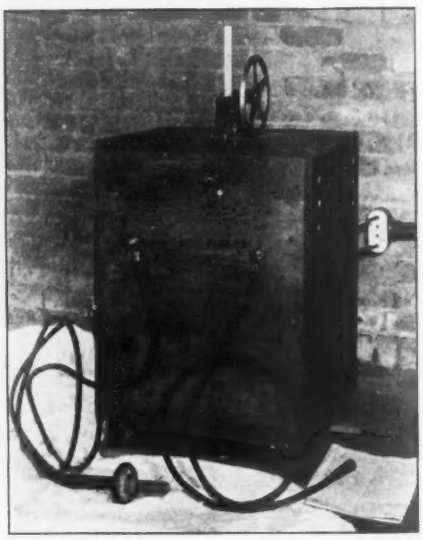
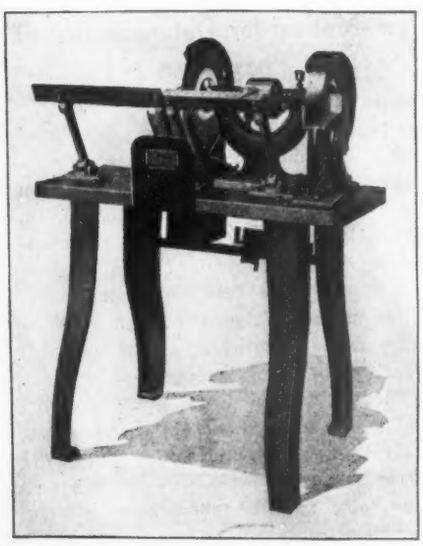


FIG. 1—TRANSFORMER WITH HAND REGULATING DEVICE FOR USE WITH WELDING EQUIPMENT

The results obtained through the two methods on a number of commercial bronzes are given in the accompanying table along with the approximate composition of the bronzes.

Produces Light Welding Equipment

With a view to compactness and portability, the Gibb Instrument Co., Detroit, has developed a welding equipment based upon the substitution of a transformer for the motor-generator set sometimes employed. This equipment which is shown in the accompanying illustration, is designed in such manner that additional units may be connected in parallel when the character of the work demands heavier power consumption. The regulating device in this installation is simple. The hand wheel shown at the top of the transformer case in Fig. 1 raises or lowers the secondary circuit within the primary coils. This obviates the necessity for any change in connections in order to regulate the arc. As the secondary is lowered within the primary, the current is increased as desired to the maximum available. It is stated that the complete equipment may be moved about and used at any point about the shop where terminals are provided to connect the power lines to the transformer. A feature claimed for this style welder is its adaptability to overhead welding. It further is stated that this device can be used to weld cast-iron and that the current consumption is low. The simplicity of the apparatus is illustrated in Fig. 2, which shows the complete unit installed and ready for use.



CUTTING-OFF AND CONING MACHINE FOR CORES

Builds New Core-Room Tool

The accompanying illustration shows a new machine developed by the Wadsworth Core Machine & Equipment Co., Akron, O., for core-room use. It is in effect two machines in one, designed for cutting off or coning operations upon cores from ½ to 4 inches in diameter. The wheel shown at the right imparts the conical shape to straight cores which are held in the rest and rotated against the grinding surface. The rest may be set to give any desired taper to the core-print. The disk wheel at the left is used to cut off cores to the desired length. The rest which extends to the extreme left provides a rigid support along which to slide the core. The projecting end of the core moves a pointer along, gaging the portion of the core which projects beyond the support to the right. This serves to measure off quickly and accurately the amount which it is desired to remove from the core. The supporting rest then is swung forward on the base, bringing the core against the cutting wheel.

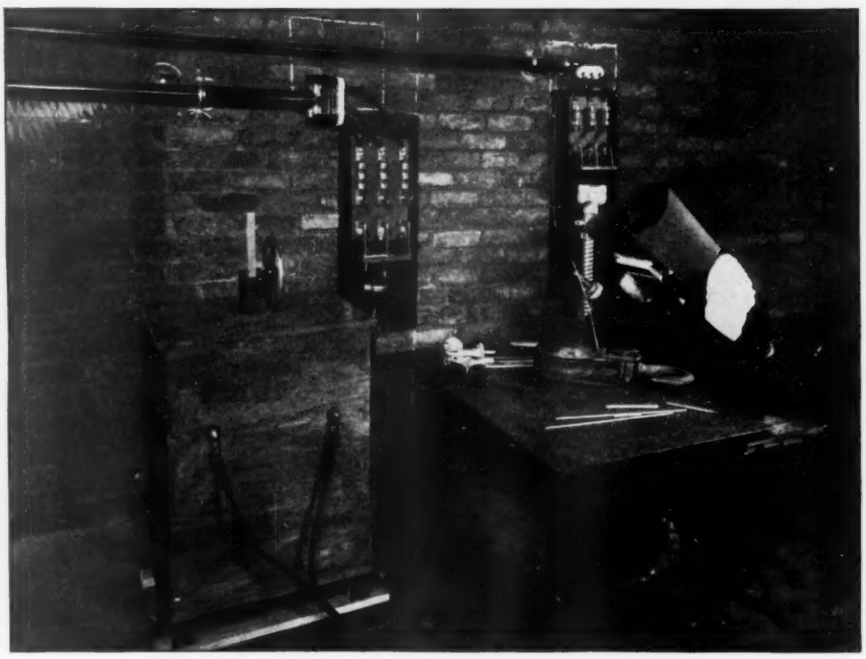


FIG. 2—COMPLETE INSTALLATION OF NEW LIGHT WELDING UNIT

Philadelphia Foundrymen Hear Building Lecture

(*Concluded from Page* 359)

construction, Mr. Conover said, is for ventilation, since the air in a building equipped with a monitor moves upward, the same as in a chimney, the amount of ventilation depending on the heighth of the building and the difference in temperature between the air in the building and the surrounding atmosphere. An instance was related where the condensation of water upon the roof of a foundry resulted in dripping upon the molds and this occasioned great trouble. Mr. Conover pointed out that condensation of this kind is due to the difference in temperature between the air under the roof and that above it, and he described an anticondensation lining which may be employed to advantage to remedy this trouble. In such cases the roof may be constructed by first stretching a layer of poultry wire, covering it with asbestos, after which tar paper and then corrugated steel are placed. The asbestos layer in this case is designed to protect the tar paper against fire. Roofs of this kind, he said, have been employed satisfactorily to prevent con-

densation in buildings of the Ludlum Steel Co. and other interests.

Steel Foundries in Brazil

The Tropenas Converter Co., 2243 Nostrand avenue, Brooklyn, N. Y., is equipping two complete steel foundries for the Brazilian government at Rio de Janeiro. A large share of the equipment has already been purchased but considerable yet remains to be secured. This company is also equipping several other foundries in South America and China for which all of the necessary machinery, equipment and supplies will be purchased in the United States. These foundries will be outfitted completely from chaplets to molding machines, elevators, etc. The construction work in South America is in charge of E. Roubieu, chief engineer of the Tropenas company. Mr. Roubieu expects to stay in South America about a year. The Tropenas company is financing its export business by means of acceptances payable 30 days after the arrival of the shipments at foreign ports. The foundries now under construction in Brazil, China, etc., will make steel casting by the converter process, using native scrap and other raw materials to accord with the miscellaneous character of the demand in these countries; they will all be equipped to turn out castings of almost every size and kind.

Westinghouse Church Kerr & Co., New York, is designing and will erect for the Vilter Mfg. Co., Milwaukee, a new office building to cost several hundred thousand dollars.

WHAT THE FOUNDRIES ARE DOING

Activities of the Iron, Steel and Brass Shops

Improvements are under way at the plant of the Aetna Foundry & Machine Co., Warren, O.

A foundry addition, 40 x 80 feet, will be erected by the Iowa Steel & Iron Works, Cedar Rapids, Iowa.

Work has started on the erection of a foundry for the Hub Electric Steel Casting Co., Boston.

The Union Steel Products Co., Albion, Mich., recently was inquiring for a second-hand cupola for melting gray iron.

A loss estimated at $40,000 recently was caused by fire at the plant of the Tacoma Foundry & Machinery Co., Tacoma, Wash.

The equipment of the Lycoming Foundry & Machine Co., Williamsport, Pa., will be increased for the manufacture of automobile motors.

At a meeting of the directors of the International Malleable Iron Co., Guelph, Ont., recently, it was decided to proceed with the erection of a new plant.

The York Mfg. Co., York, Pa., plans the erection of a foundry addition, 50 x 105 feet. E. W. Gardner, West York avenue, is purchasing agent.

Plans have been prepared for the erection of a foundry, 45 x 80 feet, for the Muskegon Tool & Stamping Co., East Webster avenue, Muskegon, Mich.

A foundry addition, 80 x 240 feet will be erected by the Howe Chain Co., Owosso, Mich., according to a report.

Plans to erect a foundry are being prepared for the United Brass & Aluminum Co., Port Huron, Mich.

T. W. Price, engineer, 233 Broadway, New York, is preparing plans for the erection of a foundry. The name of the owner has been withheld.

The iron foundry of the John A. Roebling's Sons Co., North Bergen, N. J., recently was damaged by fire.

The Ajax Metal Co., Philadelphia, has awarded contracts to M. Ward Easby for the erection of several additions to its foundry and machine shop.

The Wheeling Mold & Foundry Co., Wheeling, W. Va., plans the erection of a plant addition, 300 x 350 feet.

Erection of an addition, 35 x 78 feet, is being planned by the Chicago Stove & Range Co., Benton Harbor, Mich.

A permit to erect a plant addition has been granted to the Allyne-Ryan Foundry Co., Cleveland. The building will be 36 x 60 feet.

Plans are reported being prepared for the erection of an addition to the foundry of the Springfield Gas Engine Co., Springfield, O.

The Tri-State Engineering Co., Zanesville, O., recently was organized to operate the machine shop and foundry of the Mark Mfg. Co.

Tentative plans are under way for the erection of a new plant for the Marion Machine, Foundry & Supply Co., Marion, Ind.

Bids will be taken by the American Malleable Castings Co., Marion, O., for the erection of a foundry, 75 x 150 feet.

The capacity of the plant of the Hausfeld Co., Harrison, O., manufacturer of foundry equipment, is being doubled by the erection of additions.

The Canadian Steel Foundries Co., Ltd., Montreal, Que., recently let contracts for the erection of plant extensions at Longue Pointe, Que.

Construction of a foundry addition, 70 x 80 feet, is contemplated by the Brown Wall Machine Co., Holland, Mich.

The capital of the Newark Stamping & Foundry Co., Newark, O., recently was increased from $75,000 to $175,000.

Additions will be erected at the plant of the Enterprise Foundry Co., San Francisco, which recently was leased by the American Brake Shoe & Foundry Co.

C. B. Wilson is president of the Wilson Foundry & Machine Co., Pontiac, Mich., which is planning to erect an addition, 150 x 200 feet.

A foundry, 37 x 102 feet, will be erected by the Bronze-Alumina Corp., 16 Broad street, Buffalo, of which John H. Wilting is manager.

Bids for the erection of a core room addition, 80 x 84 feet, are being taken by the Gartland Foundry Co., Toledo, O.

The Southern Foundry & Mfg. Co., Owensboro, Ky., has been formed with $40,000 capital, to manufacture pumps, tanks, etc.

Plans are being prepared for the erection of an addition to the foundry of the Independent Stove Co., Owosso, Mich. The building will be 72 x 150 feet.

The Lutz Co., Thirty-first street and Grays Ferry road, Philadelphia, manufacturer of machinery, castings, etc., is remodeling its plant and plans to construct an extension, 55 x 330 feet.

The Chester Iron & Foundry Co., St. Louis, is reported to be in the market for structural shop and foundry equipment. A. J. Schaelich is president of the company.

The Eastern Foundry Co., Jamestown, N. Y., which recently changed hands, has undertaken the production of piano plate for the market. Thomas Watts, Matawan, N. J., is head of the company.

A recent New Jersey incorporation is that of the Standard Stove Works, Perth Amboy, N. J. The company is capitalized at $100,000 and was incorporated by Harris Edelstein, H. and J. Greenspan.

The J. C. Wilson Mfg. Co., Ltd., Belleville, Ont., recently was incorporated with $200,000 capital, to carry on a general foundry business. Harry A. Wilson is one of the incorporators.

A machine shop, foundry and power house will be erected at the plant of the Advance Pump & Compressor Co., Battle Creek, Mich. C. A. Fenn is purchasing agent.

Incorporation of the Peerless Brass Specialty Mfg. Co., New York, has been effected by R. J. Kupferman, B. Seidman and E. Muller, 1954 Sixty-fifth street. The company is capitalized at $25,000.

Levering Bros., 200 Key Highway, Baltimore, are planning to establish a foundry at Buffalo, in a building which was built during the war by the government for the Pierce-Arrow Motor Co.

Capitalized at $20,000 the Minerva Foundry & Machine Co., Minerva, O., recently was incorporated by J. B. Temple, A. B. Moore, Edward H. Boylan and others.

Two cupolas will be installed in an addition which will be erected at the plant of the Belding Foundry Co., Belding, Mich. The extension will be 100 x 117 feet.

Plans are being prepared for the repairing of the part of the foundry of the Pomeroy Machine Co., Pomeroy, O., which recently was damaged by fire.

J. Albert Ewart, architect, Booth building, Ottawa, Ont., is preparing plans for the erection of a plant for the Beach Foundry Co., Ltd., Spencer street, Ottawa, Ont.

Wells & Gray, Ltd., Confederation Life building, Sarnia, Ont., has the general contract to erect a foundry for the Romeo Foundry Co., Port Huron, Mich.

Plans are being drawn by Architects Day and Zimmerman, Sixth and Chestnut streets, Philadelphia, for the erection of a foundry at Parkersburg, W. Va. The name of the owner has been withheld.

A company is being organized at Ypsilanti, Mich., which plans to erect a modern foundry. Officers of the company can be reached through Walter Adams, 638 Dime Bank building, Ypsilanti, Mich.

The Interstate Iron Co., 104 South Michigan avenue, Chicago, recently awarded a contract to Avery Brundage, 110 South Dearborn street, for alterations and extensions to its foundry.

John N. Gill & Co., Otis building, Philadelphia, has the general contract to erect a foundry, 46 x 60 feet, for the Philadelphia Roll & Machinery Co., Twenty-fifth and Washington avenues.

Plans are being prepared for the erection of a modern foundry for the Wagner Mfg. Co., Sidney, O. The company plans to resume its job casting business which was discontinued during the war.

Construction of an annealing room, 95 x 300 feet, and a 2-story core building, 80 x 200 feet, is being rushed to completion at the plant of the Saginaw Malleable Iron Co., Saginaw, Mich. The second

floor of the core building will be equipped for a rest room and restaurant. When the addition is completed the melting capacity of the plant will be 160 tons a day.

The Polish American Foundry Co., Buffalo, which was incorporated some time ago, recently leased a foundry at Elmwood and Hertel avenues, Buffalo. S. Marciniak, 580 Amherst street, is manager.

The J. D. Fate Co. and the Root-Heath Mfg. Co., Plymouth, O., have consolidated under the name of the Fate-Root-Heath Co. The combined plants will be enlarged by the eection of a foundry, 120 x 180 feet.

Plans have been completed and bids are being received for the erection of a plant for the Keystone Iron Works, Merchant National Bank building, Los Angeles. The plant will include a foundry, 100 x 438 feet.

The proposed plant of the recently incorporated Newport Foundry & Machine Co., Newport, Ark., will consist of a machine shop and foundry, 70 x 100 feet. The contract for the erection of the building has been let.

A recent incorporation is that of the H. & H. Foundry Co., New York. The company was incorporated in Delaware with $1,000,000 capital, by Robert K. Thistle, Samuel B. Howard, 65 Cedar street, and others.

Among the recent incorporations is that of the Liberty Car Wheel Co. of Hammond, Ind. The company has been capitalized at $5000 and was incorporated by Charles Aaron, Franklin Rabe and Charles E. Clarbe.

Contracts have been awarded by the E. W. Bliss Co., 17 Adams street, Brooklyn, N. Y., for the construction of a machine shop and foundry. The machine shop will be 80 x 380 feet and the foundry, 80 x 240 feet with a 3-story extension.

Bids are being received by Gardiner & Mercer, 827 Birks building, Vancouver, B. C., architects, for the erection of a pattern shop, foundry, etc., for the Mainland Engineering Co., 442 Railway street, Vancouver.

Architect Ferdinand Savignano, 6004 Fourteenth street, Brooklyn, N. Y., is drawing plans for the erection of a foundry, 60 x 100 feet, which when completed will be leased by the Nelson Iron Works, 252 Fortieth street, New York.

Among the recent incorporations is that of the Superior Bearing Bronze Co., New York. The company is capitalized at $20,000 and was incorporated by A. Baugerter, A. Partman and L. Gutheil, 739 Home street.

A contract has been awarded by the Cedar Rapids Foundry & Machine Co., Second avenue and Tenth street, Cedar Rapids, Iowa, for the erection of a foundry, 65 x 95 feet. R. Lord is president of the company.

The Pittsburgh Perforating Co., Pittsburgh, has leased the machine shop and foundry of the Best Engineering & Mfg. Co., on Railroad street, for a period of three years. The building is 100 x 106 feet and will be utilized for the manufacture of perforated products and metal specialties.

Capitalized at $150,000, Josiah Anstice & Co., Rochester, N. Y., has been incorporated to engage in a general foundry business. The company was incorporated by J. Anstice, 265 Culver road, M. R. Anstice, East boulevard, and J. F. Weller, Brighton, N. Y.

As soon as insurance matters, etc., have been adjusted, the American Beauty Stove Co., Erie, Pa., plans to build a modern plant to replace one recently damaged by fire. For the present, the damaged buildings will be repaired, and used until the new plant has been completed.

Bids are expected to be closed shortly for the erection of a modern foundry, 74 x 160 feet, for the Nickel Plate Foundry Co., East Cleveland, O., which was incorporated several months ago. R. F. Chamberlain, 948 Engineers building, Cleveland, is acting secretary of the company.

Active operation of the former plant of the Angels Iron Works, Stockton, Cal., has been started by the H. C. White Foundry Co., engineers and founders, which was recently incorporated with $50,000 capital. Officers of the company are: President, H. C. White; vice president, Frank S. Guernsey, and secretary and treasurer, L. F. Grimsley. The company will manufacture gray iron castings.

Work has started on the assembly and stock building, 192 x 1057 feet, for the Studebaker Corp., South Bend, Ind. The machine shop is partly constructed and plans are being prepared for a foundry, power house, press steel stamping plant, heat treating and carbonizing plants.

Among the recent incorporations is that of the Bass Foundry & Machine Co., Ft. Wayne, Ind., which has been capitalized at $1,700,000. The incorporators are John H. Bass, Gaylord M. Leslie, Charles T. Strawbridge, William C. Slater and James M. Barrett.

Small and medium sized gray iron, brass and aluminum castings will be manufactured by the Keystone Foundry Co., Plymouth, Ind., which was recently incorporated with $10,000 capital. The company at present is building a plant. J. E. Fogarty, formerly of the Electric Steel Co. of Indiana, Indianapolis, and George Pohl, formerly of the Hill Pump Co., Anderson, Ind., are officers of the new company.

NEW TRADE PUBLICATIONS

WELDING APPARATUS.—W. B. Perdue, 1220 Post street, San Francisco, manufacturer of welding and cutting torches, regulators, supplies, etc., has issued an illustrated booklet in which his products are described. The booklet gives data pertaining to the various accessories, and among the illustrations is one showing the cutting of a large ingot.

ELECTRIC HOISTS.—The Electric Hoist Manufacturers' Association, New York, has issued an attractive catalog suggesting uses for electric hoists in foundries, machine shops, shipyards, paper mills, shipping rooms, boiler making plants, etc. The booklet is fully illustrated and shows actual installations. One illustration is a line drawing of an electric hoist coal handling system.

GEARS.—A 96-page illustrated booklet of the pocket-size type, describing and illustrating gears of all kinds, is being distributed by the Boston Gear Works, Norfolk Down, Quincy, Mass. All data and specifications pertaining to the company's products are listed. An interesting part of the booklet is that section devoted to tables giving the diametral pitch, circular pitch, strength of gear teeth, weight of brass rods, weight of steel rounds, etc.

STEEL FOUNDRY.—The Canton Steel Foundry Co., Canton, O., recently issued a 28-page booklet, containing illustrations of its plant and a number of its products. Among the illustrations are a birdseye view of the plant; the chemical laboratory; the 40-ton open-hearth furnaces; a section of the dry floor; drying ovens; core room; molding floor and pattern shop. The products which are illustrated consist of a number of large castings, including couplings, annealing boxes, gun mount frames, press platens, etc.

CONVEYING EQUIPMENT.—A well illustrated 96-page booklet, in which conveying equipment for handling coal, coke, ashes, cement, sand, stone, ore and similar materials is described, has been prepared by the Link-Belt Co., Chicago. The conveyor consists of a continuous series of buckets, pivotally suspended between two endless chains, which maintain their carrying position by gravity, while being carried either horizontally or vertically. The buckets are supported by rollers. Many illustrations of working installations and a number of line drawings are given.

WATER HEATERS. — A well-illustrated, 16-page booklet recently was published by the Griscom-Russell Co., New York, in which feed water heaters are described. These heaters are made with cast-iron shells. The coils are helical. This imparts a whirling motion to the water. The rapid agitation of the water, it is said, results in remarkably high heat transfer. The coils are interchangeable. According to the booklet, the coils and joints may be inspected and made tight while under boiler pressure without the necessity of breaking pipe-joints. The various parts of the heaters are illustrated and a number of line drawings given.

BRASS FURNACE BURNER.—An illustrated 8-page booklet has been issued by the Maxon-Premix Burner Co., Muncie, Ind., in which a furnace burner manufactured by the company is described. According to the booklet the burner mechanically mixes air and gas. It consists of a ball bearing motor direct-connected to an aluminum impeller housed within a semisteel blower casing. The gas supply enters through an inlet with an adjustable cock, which is operated with a rotating shutter by a geared single lever for governing the air supply. A part of the casing is cast with a base upon which the constant speed motor is aligned and the switch mounted.

ENGINE LATHES.—An illustrated booklet of 32 pages has been issued by the Greaves-Klusman Tool Co., Cincinnati, in which a general description of the salient features of engine lathes manufactured by the company are given. According to the booklet, heavy ribbing extends the full depth of the bed and reinforcements are placed under the vees which extend below the tops of the girths. The headstock is heavy with ample internal bracing, and is bolted to the bed with six bolts. The spindle is turned from solid, high-carbon steel. Other parts of the machine are described and numerous illustrations, including several of machine attachments, supplement the descriptions.

CRANES.—Bulletin No. 106, describing and illustrating traveling cranes, recently was published by the Champion Engineering Co., Kenton, O. According to this bulletin, the side frames of the crane consist of two heavy castings connected by a wide steel girt or separator. The separator carries the hoisting motor, and the motor electric brake is fastened to the side frames by bolts. All shaft bearings on the hoist are alike and interchangeable and all shafts are made of forged high-carbon steel. The trolley track wheels are heavy and are furnished either of cast iron with chilled ground treads, as standard, or if desired, cast steel wheels are used. The flanges are heavy and the wheels are keyed to the axles revolving in phosphor bronze hexagon bearings. Many illustrations, including line drawings and actual installations are given. One page of the booklet is devoted to safety signals adopted by the Emergency Fleet corporation for the operation of cranes.

GRINDING WHEELS. — The Bridgeport Safety Emery Wheel Co., Inc., Bridgeport, Conn., has issued a catalog covering its complete line of grinding and polishing machinery, and appurtenances. Tables and accompanying definitions covering grain size, wheel diameters, speeds, and wheel types comprise the forward section of the booklet. A wide variety of both wet and dry tool grinders for belt or motor drive next are illustrated and described. A new type of wheel built up from a number of sections of the abrasive material held in place by a system of screws and wedges between an outer chuck and an inner ring is prominently featured. This wheel was designed to provide spaces between abrasive sections into which the material ground from the metal or the wheel itself might find escape. Both motor and belt driven swing grinders are illustrated. These have overhead support, and power is transmitted through either a V-shaped or flat belt vertically from the main shaft and thence horizontally through another belt to the wheel. A universal joint system permits movement in the wheel vertically, horizontally and laterally. Special grinders for a wide range of uses occupy the last half of the catalog.